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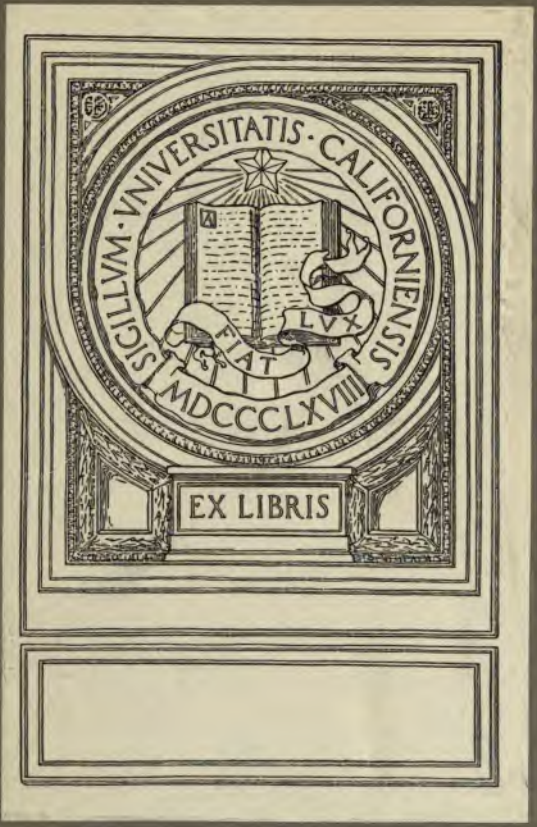
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SUGAR CANES

AND THEIR PRODUCTS

Culture and Manufacture,

—BY—

ISAAC A. HEDGES,

AUTHOR OF

"SORGO, the NORTHERN SUGAR PLANT,"

—AND—

President of Mississippi Valley Cane Growers' Ass'n.

WITH AN INTRODUCTION ON SUGAR,

BY

GEORGE C. W. BELCHER,

of St. Louis, Mo.

Published by the Author.

ST. LOUIS, MO.
1881.

TP 405
H 4
1881

Entered according to Act of Congress in the year 187-
BY ISAAC A. HEDGES,
In the office of the Librarian of Congress at Washington, D. C.

Stereotype Edition

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INTRODUCTION.

It is to be regretted that the chemistry of the sugars is still in an unsettled condition. The expenditure of much sincere work has not sufficed to clear away the clouds. When we pour sulphuric acid upon carbonate of lime, we know exactly what is the result of the chemical changes which take place But when we boil a solution of cane-sugar with free sulphuric acid there is formed a mixture of two organic substances one of which though often introduced to us is yet a comparative stranger. Both cane-sugar and grape-sugar admit of accurate study and the determination of their properties, but what shall we say of *fructose*, or (as we learned to call it) *levulose*, or (as we now hear it called) *chylariose*? What shall we say of the many gums and semi-sugars which are present in all cane-juices and which vary with the climate and the zone? Some of these polarize and others do not; none crystallize, but all hinder the filtration and crystallization of the cane-sugar commingled with them. For none is there any simple quantitative test: many can barely be distinguished qualitatively; still others are, to all intents, unknown substances.

It is the misfortune of organic analysis that its hands are often thus tied. Not only are organic substances extremely delicate in constitution, but ultimate analysis, so useful in organic chemistry, is here sometimes completely at fault. It is useless to demonstrate

that a substance is composed of a certain amount of oxygen, a certain amount of hydrogen, and a certain amount of carbon, when there may be three different substances of the same composition, and the one under investigation may be a mixture of two or more of these. A great deal is expected of sugar chemists that they are really unable to go. After all known tests for the value of raw sugars have been exhausted, there still remains an important per centage of undetermined matter which will turn the scale for or against the profitable working of the sugar.

The corrections of the polarization test are not sufficient to fix the amount of cane sugar present. And just here there is a very prevalent fallacy, namely, that sugars polarizing the same are of equal value. This is an error and has given rise to much misunderstanding. *Raw sugars cannot be compared simply upon a basis of polarization, except when produced in the same country and by similar methods of manufacture.* A muscovado sugar and a molasses sugar, both produced in Cuba and polarizing the same, are of very different value. Of still greater difference in value are sugars from Cuba and Louisiana, though they may polarize the same to a tenth of a degree. In other words, there are unknown substances yet beyond our grasp, which vary with the climate and the soil and affect the polarization test of raw sugars

Yet we do not wish to discredit the polariscope, nor the optical test of sugar, It is a long step into the darkness, even if it does not take us all the way through. It is encouraging to note that the use of this instrument is extending. No refiner can be without it for a day. We would not hesitate to recommend it as an economical investment for a planter of a few hundred acres. We only caution some persons against expecting absolute answers to their questions where, from the nature of the subject, only approximate ones can be given.

There is a large field open to the planter in the use of the polariscope To study the growth of the cane from day to day, and the formation of cane-sugar in the juice, noting carefully the conditions of the soil, all fluctuations of the weather, and any abnormal or accidental influences. Such an opportunity well improved might enrich the chemistry of sugar in a marked degree. Other methods of

analysis would be available, especially (on clear days) Fehling's copper test. We are not aware that anything systematic and thorough in this line has ever been done, and if not it is a surprising omission. The optical test is so speedy and simple as to peculiarly fit it for such work; and the polariscope is now in such common use that there is no reason why we should not know exactly when the formation of cane-sugar in the juice begins, how rapidly it increases, when it is completed, and what causes affect the operation, either favorably or not. Careful and accurate observation is the foundation of all knowledge. And although we may never be able to put together carbon, hydrogen, and oxygen so as to form cane-sugar; although we may never do more than save from decomposition the sugar which nature has already formed for us; still we can by patient study learn more and more of the mysterious processes by which the components of air and water are changed in the cane-stalk into crystal sweetness.

(We must apologize here for an unavoidable confusion of terms. In order not to use the word *sucrose* which is strange to most readers, we have used *cane sugar*. not merely in its chemical sense as distinguished from glucose (grape-sugar), but also in its ordinary signification, i. e.,the product (raw or refined) of the sugar-cane as distinguished from the product of the beet. We trust that the context will make all passages clear)

CANE-SUGAR.

The idea has somewhat obtained of late that the production of sugar from the cane is falling off and that this result is in a measure due to the large extension of the sugar beet. This is erroneous. Undoubtedly the sugar production of some cane-growing countries has long been at a stand still while in others it has perceptibly decreased, but many causes have conspired to produce this result.

In the first place, the fertility of the soil and the mildness of the climate both tend to relax the energy of the planters and thus retard progress. Secondly, the presence of slave-labor discourages the use of machinery and the efforts of inventors. Why should machinery be devised to save labor, when labor costs nothing? Why should so much trouble be taken to get a small gain in the

yield of the crop, when, excepting disastrous and unforeseen weather, the planter is assured of pecuniary profit without departing from time-honered means and methods?

Lastly, beet-growing countries are still barricaded by a protective tariff. The ultimate benefits to them of this condition are questioned by many, but as to its immediate effects there can be no doubt; indeed, the beet industry of Europe is a rock on which a protectionist can stand a long time quite safely. The whole subject of tariff is so constantly under discussion and is so tempting to argument, that we shall omit anything beyond a mere mention of the situation. To consider the cane-growing countries overmatched by protective legislation is to disregard the fact that from its very inception the manufacture of beet sugar has been fostered with great care, and diligently studied in every point and with all the light that science could cast upon it. A similar course in cane-growing countries would have astonished the planters by its results and a few shining examples of recent progress afford sufficient proof.

The cane-sugar production of this world can be estimated at about 2,150 000 tons. Accurate figures are difficult to obtain owing to the absence of official statistics in most countries. The total is probably about the same as two years ago. Of this amount Cuba produces nearly one-third. No other single country produces over 200,000 tons. Any disaster to the Cuba crop consequently affects the market to a large extent. Of late years the influence of the crops in more distant countries, such as Brazil, Java, and the Philipine Islands, is sooner felt than formerly, owing to the extension of commercial relations

We have just alluded to some cases of unusual development. In a majority of these we notice the direct influence of English skill disseminated by commerce through distant parts of the world. The most rapid growth of importance has occured in Egypt where the production now exceeds 40,000 tons. The exports increased from 1866 to 1875 over 800 per cent. The Khedive, among his numerous extravagancies, has been in no wise backward in sugar manufacture and the result is the introduction of the best machinery with skilled labor to work it. This will be a better legacy for the Egyptian nation than many others he will leave. British

Guiana, or Demerara, is probably the furthest advanced of cane-growing countries. Vacuum pans have been in use here for upwards of thirty years, and are now the rule, not the exception. Demerara sugars have always ranked high in popular esteem, and a large proportion goes into direct consumption It was the high-testing and low-colored centrifugal sugars from this colony that lately gave rise to legal action in the United States. In Queensland the culture of the sugar-cane is extending very rapidly. Not only are the soil and climate favorable, but the planters and refiners have hastened to avail themselves of the most approved methods of working. Peru shows a constant increase in the production which is nowestimated at over 70,000 tons. Most of the Peruvian crop is imported by England; and in this country, as well as in Egypt, Demerara, Queensland and many others, English science and English machinery have in a great measure turned the wheel of progress.

There are some countries where special causes have operated to increase the production. The Philipine Islands have been benefited by a growing demand for low grade sugars for refining purposes, particularly in the United States. The product of those islands has been lately estimated at 130,000 tons, but the manufacture is crude and there is consequently a fine opportunity for still further advances. The Sandwich Islands are just now in rather a unique position owing to the effects of the reciprocity treaty with the United States, whereby all sugar produced in these Islands is admitted to the United States free of duty. Of course, such a bonus as this is very certain to stimulate the efforts of the planters, as it insures a very handsome margin for profit. The production was estimated at over 12,000 tons in 1874. Later figures show a large increase.

It is interesting to note the gradual adoption of sulphur processes in different cane-growing countries. Though varied in name and and in details, they are more or less the same in the general principle This is the substitution of sulphurous acid in an organic salt of an inorganic base, thus setting free the organic acid, which is volatized and driven off. This reaction is usually accompained by some improvement in color. That sulphurous acid also

defecates gummy solutions, must be believed from the weight of testimony in its favor. Indeed the utility of this re-agent in the manufacture of raw sugar from cane-juice would seem to be fully demonstrated. Yet, singularly enough, the benefits of its employment in the refining of cane-sugar are at least doubtful. Some experiments have apparently given good results, and others have been indifferent or disappointing. It is not, however, injurious in any way, and the most that is claimed against it is that it is superfluous.

Prominent among countries adopting the use of this agent in some form are,—British Guiana, where the use of bi-sulphite of lime has long been in vogue; Egypt, where factories have been built, specially planned for the use of sulphurous acid; Porto Rico, where it has been long and successfully used; Jamaica, St. Croix, and many others, where it is being introduced and favorably received; Mauritius, where is being largely adopted what is known as the "Icery Process" an application of the monosulphite of lime; and (most familiar to all our readers) Louisiana, where the use of sulphurous acid, or of bisulphite of lime is so general as to seem almost a necessary feature of sugar manufacture. Efforts have been made to adopt the Diffusion Process, so popularin European factories, to the needs of the sugar-cane planters, but so far success has been doubtful. It was tried in Louisiana. It is now being worked in Madras, where great success is claimed and an increased yield of 20 per cent. Unless carefully managed, this process is apt to enlarge the cost of evaporation very materially.

BEET-SUGAR.

The culture the of sugar-beet has steadily increased until now it may be considered a permanent part of the agriculture of three-fourths of Europe. From France to Russia, from Italy to Sweden this industry has spread. In the central portions of the continent it is of the greatest national importance. As such it is regarded, and although in some countries heavily taxed, it is amply protected against the competition of cane-products. The circumstances which favor it are;—a suitable soil, a climate uniform but not too hot, cheap manual labor, and a thrifty and intelligent agricultural pop-

ulation. These conditions are difficult to combine in a newly-settled country, and, not unexpectedly, experiments in beet-culture here have proved failures. The last attempts, in California and Maine, seem to promise better results; and it is certainly reasonable to believe in success somewhere between the two oceans.

In 1860 the beet-sugar production of Europe was estimated at less than 450,000 tons; the present crop (1878-9) will aggregate, according to the latest calculations, 1,490,000 tons. During the same period the cane-sugar production of the world has increased in a much smaller ratio.

One admirable feature of this industry is the abundance of statistics which are accessible to the interested public. Accurate statements of production and consumption in many cane-growing countries are a desideratum.

SUGAR REFINING.

Much of the present development of sugar production is due to the energy and skill of the refiners. They have been ever foremost in the introduction of improvements and to them the producers of raw sugars (both cane and beet) continually look for new ideas and inventions. It is to the credit of the sugar refiners that they have kept full pace with the most progressive of manufacturing industries, and that by no trade trickery, but by legitimate methods of working and by persevering enterprise the cost of refining sugar has been reduced 60 per cent. in the last fifteen years. A first class refinery can now put its raw material into marketable shape at a cost of five-eights of a cent per pound, and this including interest, wear and tear of machinery, etc., etc.

Sugar refining, as now practised, is in its general outlines much simpler than formerly. All superfluous overworking is being fast dispensed with, and the complications that characterized the old mould houses are now well nigh forgotten. On the other hand, the important features are studied more carefully than ever before. Such are,—the proper working of the bags, the management of the char, its washing and revivification, and the disposition of the sweetwaters, etc. Most refineries refer constantly to the polarity of their liquors and syrups as a guide for working, and not a few

the value of the raw material but that of the refined product is determined in the laboratory.

The one cardinal principle in the refining of cane sugar is to expose the sugar to the influence of heat no longer than is absolutely necessary. The ideal of col l working is, with the present methods of filtration, unattainable, but the disastrous effects of continuous heat, especially in the presence of soluble impurities, must be kept constantly in mind. This is a matter which equally concerns the producer of raw sugar and it is beginning to be appreciated i n cane growing countries. A vacuum pan is the cheapest piece of machinery a sugar planter can own, and were all raw sugars boiled *in vacuo*, the production of the world would be wonderfully increased.

It is beyond the scope of this article to refer otherwise than in general terms to the great improvements in all sugar house machinery; especially, the perfection of vacuum pans, with their con densers and air-pumps; the increased capacity and novel construc tion of the bag-filters and char-cisterns and revivifying kilns; and above all, the number and ingenuity of labor-saving devices. In this latter point, probably no other branch of manufacture will show greater progress in late years than the leading refineries of England and the United States. As a consequence, some establishments have attained a colossal size, and wield a direct and indirect influence upon trade, measured by millions of invested capital and thousands of interested employees.

Marked chan ges in the character of the refined products may be noted. There is a large decrease in the quantity of molasses that is turned out, it being no longer as renumerative as formerly. This is occasioned by the cheapness and attractiveness of what are known as corn-syrups, which are mixtu es of dextro-glucose with about 20 to 30 per cent. of some low-colored refined or unrefined molasses. The extraordinary quantity of yellow sugars now turned out is another feature. There is fashion in sugars as well as in silks and satins. The snowy loaves that formerly adorned the grocers' windows are gone and the public taste has been educated to the consumption of sugars of the cheapest face-value. This style of g oods has been pushed to an extreme, and some revulsion

in feeling has already been manifested. There is more than a possibility that refined sugars may yet be sold on a basis of polarization. Such a course could only give satisfaction, for if a man should choose to buy a sugar polarizing 80 and pay what he considered a fair value, it would be the same as if instead of buying an all-woolen shirt, he selected a wool and cotton mixture. The polariscope test for sugars would be simple and expeditious. and the color would still remain an additional consideration.

* * * * * *

The manufacture of sugar from the beet, and its refining will always differ in many respects from the treatment of cane-products. The almost total absence of "inverted sugar" permits an alkaline working, and this in its turn the use of heat to an extent unknown in factories which handle the latter class of sugars.

The general features and the machinery employed are very similar, so much so that a refinery proper may be equally adapted for working raw sugars of either class. But the method of defecation by over-liming modifies all following processes, and we see in beet-sugar refineries. hot-boiling and strong crystallization, with the syrups constantly separated and worked down until the residue is an unmanageable mixture of salts, gums, and imprisoned cane-sugar, fit only for the distiller's use. This is more properly sugar-refining than the methods now in fashion in England and the United States. But it would not pay, except with beet products or very high grades of cane-products. In Europe refined sugars are almost all pure white, and are sold with a strict regard to chemical test; here they are classed and sold by color only. There they buy almost no "inverted sugar" in their raws; here they buy plenty and must sell it in their refines in order to make both ends meet.

As might be expected the working of beet-products continually invites chemical treatment. It is wearisome to study the various processes devised and experimented with in France and Germany. Many of these are for the recovery of cane-sugar from beet-molasses, and are wholly inapplicable to cane-products. Some serve to economize bone-black, and a large number are methods of defecation. One process of considerable importance has been adopted with great success by an English refinery. It is applicable to all raw

sugars containing less than two per cent. of "inverted sugar". It is called by the name of the clarifying agent used— 'The Sucrate of the Hydro-carbonate of Lime Process', or by the name of its inventors "The Boivin and L'Oiseau Process". The refinery of Mm. Sommer & Co., Paris, has been working this process for years.

GLUCOSE.

Before closing it may be well to speak of another industry which has come prominently into notice of late years and which partly from a confusion of ideas regarding the character of its products, and partly from having adopted some of the methods and machinery of sugar-refining, has been more or less associated with it in the popular mind We refer to the manufacture of glucose and dextro-glucose. The recent increase in the consumption of these articles is enormous. The cost of production has so diminished that for many purposes for which it is equally adapted, cane-sugar is no longer available, being hopelessly undersold.

Although glucose (grape-sugar) was known to the commercial world many years ago, it has only been within the last ten years, that its manufacture has assumed any considerable proportions. The theory of the process is familiar to our readers. It is the conversion of a solution of starch into a solution of glucose by boiling with free sulphuric acid, the acid being removed after the conversion by the addition of a small quantity of lime, an insoluble precipitate of sulphate of lime being formed. This simple operation is the foundation of an industry now taking high rank among others and gathering around it all the accessories consequent upon such position. Flourishing equally well in many parts of the United States, glucose manufacture has developed most largely at Buffalo, N. Y., where the low cost of the grain and the extended shipping facilities both east and west, have stimulated the energy of the manufacturers.

It is only right that all fair minded persons should deprecate the prejudice that was recently stirred up against the products of the glucose factories The charges of wholesale poisoning, and of ruining the public health by inducing varions forms of abdominal disease, would be ridiculous, were they not malicious in thei-

tendency. Glucose never did and never will compete with cane-sugar as a sweetener. But as a basis of fermentation it is not only much cheaper, but in some cases otherwise preferable. This is properly its sphere of usefulness. The difference in price between grape-sugar and cane-sugar is so great that were it feasible, there would be temptation to use the former as an adulterant of the latter. But this has probably never been done, and if a method of crystallizing the two together should ever be discovered, the public taste and the market price would soon settle the question. The effect upon the health of the consumer would be same as when coffee is "stretched" with chicory, or claret with water.

PRESENT QUESTIONS.

Whatever may be the future of the sugar industry in this country, the refining branch seems destined to remain. Whether beet culture will prove successful on a large scale, whether cane-sugar can be economically extracted from the juices of sorgo and maize are yet to be determined. The production of raw sugars depends upon climatic conditions, peculiarities of the soil, and the economy and energy of the agricultural class of population. But sugar-refining will always thrive in the busy manufacturing districts where nature's reservoirs of coal and water are at hand, and cheap transportation enables the refiner to meet the consumer's wants with ease and safety.

Probably nowhere else in the world has the margin for sugar-refining been figured so closely as in New York, nowhere else has there been displayed so much enterprise and skill. The remarkable growth of this business there in the last fifteen years bears ample testimony to the quality of American brains.

But back of all individual efforts, no matter how skillfully directed, lie causes deeper and more potent. The influences of legislation for good or evil we may yet recognize more clearly than we have ever been called upon to do Our trans-atlantic cousins can tell us a great deal about sugar legislation, how it works in theory, and in practice. Congress has it in its power, by ill-advised action, to make the refining industry a national monopoly, or to close the doors of every refinery in the country.

There is another point worthy of study. It is what might vulgarly be termed "the path of empire." The development of trade-centers, like centers of population, is determined by definite causes. So far we have seen one sugar-mart grow to the exclusion of others. New Orleans, Baltimore, Philadelphia, and Boston have each enjoyed special advantages, but New York has far outstripped all. Now, it is reasonable to expect one or more additional trade-centers to rise into prominence with the growth of such a large country. If raw-sugars continue to be imported, San Francisco has the most promising future. If domestic cultivation of sugar-yielding plants is destined to supply a fair portion of our wants, no city is better located to secure a leading position than St. Louis. Even her neighbors and rivals in other branches of trade will concede that this conclusion is well founded.

But, turning from what may seem a side-path, the question of the ability of the world to dispose of the increasing product of the cane and beet is one that is often seriously considered and has given rise to much doubt and discussion. The truth is, that the world's consumption of sugar is continually increasing. Local checks occur when prices reach a prohibitory figure, but when prices fall again the lost ground is regained. The consumption in Great Britain per head of population nearly doubled from 1855 to 1875. Other countries show even larger gains. Sugar has long ago disappeared from the class of luxuries and become a staple article. It has been put to an ever-increasing variety of uses; the preserving and canning trade have made the summer months the best market season. In great Britain, when prices are very low, sugar is used in large quantities for brewing, and it is stated that the poorer qualities are used to a considerable extent for feeding stock. It is difficult to say that a limit to consumption has yet been reached. If sugars should be cheapened by any means one third or one half of their cost, new outlets, not now considered or even known, might market a much larger production than the world has ever seen.

If maize and sorgo should, by improved culture, gradual changes in character, or other means, be brought into the rank of sugar-producing plants, something like this must happen. Competition

among farmers would reduce prices to an extent which would evoke new uses and adaptations. The United States might or might not export raw sugar; they certainly would use a great deal more than they do now.

In closing, we would only add that if we have seemed to speak vaguely or distrustfully on any point, it is not because we have prejudices, but because it is sometimes so hard to be sure of a fact, and so easy to pretend to be sure of it. There is nothing more inviting than the study of sugar from its birth in the cane field through all its checkered life. And if anything we have said shall induce an increased interest on the part of any reader, we shall feel amply repaid for our trouble.

ST. LOUIS, APRIL 2, 1879.

The Northern Sugar-Cane.

CHAPTER I.

Embracing Convention Proceedings on this subject.

The purposes of this work being especially as an instructor, I do not propose to go into the history of these Northern Canes, except so far as to trace those now most in use as preferable for general cultivation, and for that purpose I shall here introduce my paper, read before the late convention at St. Louis. But to those desiring the more general history, I would recommend the work "Sorghe and Imphee" *by Olcott.*

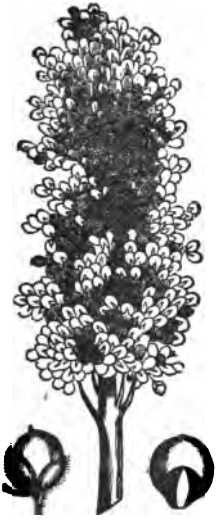
That there are now several new varieties of these canes, as a result of hybrid there can be no doubt. This crossing has resulted, as I predicted sixteen years ago, in an improvement of the canes, new names are being given these crosses, such as Early Amber, which I cheerfully accept as more appropriate than the Zulu Kaffir, names which are difficult to pronounce or spell. I have arrangements made for pushing the subject of improving our varieties still further by hybridizing the most desirable kinds, and selecting the most precocious and best seed heads. The facilities we have for changing seeds from North to South and

vice versa is quite fortunate. There is probably no other crop cultivated that is so materially and favorably affected by change of latitude as these canes, although the cost of seed is increased some, yet it is insignificant when compared with most other field crops, as two pounds will plant one acre, which can now be had by mail for $1.00, while to plant southern cane it will cost at least $30 worth of cane, besides the extra labor of first burying it to protect it from the frost during the winter, and then taking it up and planting again. Hence, if we are unable to obtain as large a yield of sugar per acre, still that which we do get will cost us less for cultivation, and then we obtain an amount of forage and seed for stock feed that will, when rightly handled, pay all the expenses of cultivation and delivery to the mill. This position is fully sustained by the statements of different farmers as hereafter reported in this book. I cannot urge too strongly the necessity of utilizing every portion of this crop in order to make it remunerative.

Why waste the forage of this crop and then have to replace it with its equivalent of some other. In order to handle this forage correctly, calculations and preparation must be made in advance, so that when the season for taking it in hand comes, there will be no detention or neglect, consequent upon a want of readiness. There is, probably, no one feature of the farmer's operations in which he suffers as much as in the deficiencies, from a want of a thorough study of their new engagements, prior to their commencement.

The permanent organization now effected here, if sustained by those so directly interested, will, by their correspondence and annual reports, disseminate information that must result in a great mutual benefit.

No. 1.

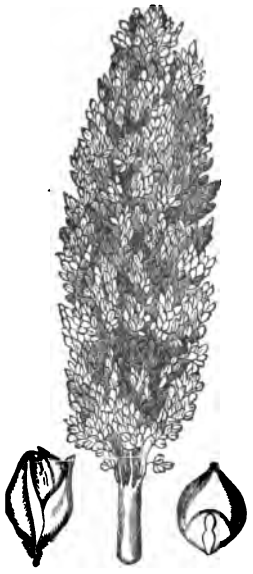


No. 2.

No. 1 tuft is a representative of what appears a crop of the Liberian, one of our most productive canes, with some other, giving a larger stalk than the Early Amber and a seed much like it. It is highly recommended. I shall have it carefully cultivated and tested in order to learn its merits as a sugar-producer. The general contour of the tuft is like the Liberian, but the kernel more like the Early Amber.

No. 2 is another more closely resembling Early Amber, but still the farmer who produced it had the latter also, and says, there is a marked difference. The sample of sugar he sent me is a coarser and harder crystal than any I have yet met with. I am having a barrel or more of the sugar sent me and will swing it and apply the polariscopic test. Should it result satisfactorily I shall endeavor to place enough of this seed in cultivators' hands for future test, and

No. 3.



OOM-SEE-A-NA.

REGULAR CHINESE VARIETY.

report—which with my arrangments in different latitudes will afford satisfactory results. My great desire is, to determine this year, if possible, the best variety for sugar.

No. 3 is a tuft of Oom-see-a-na. Although a good cane it is, like the Chinese, falling out of favor. It, no doubt will do well as a party to hybrid with other early-sweet varieties and thereby obtain a larger product than the Early Amber by itself.

SEEDS, THEIR VARIETIES AND ORIGIN.—BY I. A. HEDGES.

There are several species of Canes or Plants that possess Cane Sugar, the most prominent of which is that of the tropical, known by the Latin name of Saccharum Officinarum or Southern Cane, of which there are several varieties. But the Canes that form the subject for which this convention has been assembled, are commonly called Sorghum, and classified by Linneus as Holcus Saccharatus, and have come to us from two widely distant points of the Eastern hemisphere, viz. N. E. Asia and S E. Africa; each, however, were reproduced in France before reaching us. This is Chinese, a fair specimen, as you will see it has a center spindle, with long foot-stalks standing on all sides around the stalk, bearing large seed covered by a black pellical.

The stalk grown in good soil will attain an average of about 10 feet, with joints about 10 inches apart, stalk about one inch in diameter, of a deep green color, slightly covered with a whitish wax; matures its seed in about three and one-half months. The principal objection to it is a liability to fall before the wind and make harvesting expensive, while the juices do not possess quite as much cane-sugar. For its introduction into this country we are indebted to our government.

The African varieties were collected by Mr. Leonard Wray, of England, who found them growing extensively among the Kaffirs of S. E. Africa, where he spent some time in experimenting with them in sugar-making, being himself a practical sugar-maker and author. Finding them a genuine cane-sugar producing plant, and maturing in a few months after planting,

he became greatly elated with the prospects before him. He gathered seed from fifteen varieties, each of which had a specific name, but as a whole genus they were called Imphee, which, I presume, is peculiar and belongs to the natives, as I have never met with it elsewhere. The names of the different varieties as given by Mr. Wray, are equally peculiar, as follows; Vim-bis-chu-a-pa, E-a-na-moode, E-enga, Nee-a-za-na, Boom-vwa-na, Oom-see-a-na, Shla-goova, Shla-goone-de, Zim-moo-ma-na, E-booth-la, Boo-ee-an-a, Koom-ban-na, See-en-gla, Zim-ba-za-na and E-thlo-see.

All these varieties Mr. Wray had reproduced in France, where he made sugar from them of a quality similar to those best samples on exhibition here. Mr. Wray having met the late Horace Greeley in France, was persuaded to come with his seed and samples to this country, where he arrived late in May, 1857, with 1,500 pounds of seed in the tuft, most of which was planted by the late Gov. Hammond of South Carolina. but, by an urgent application, assisted by my friend H. Greeley, I obtained enough to plant ten acres of the earliest varieties, which I had planted upon the farm of Brutus J. Clay of Kentucky, June 10th.

Mr. Wray only got his seed into the ground on the 20th of June. The season there was very wet (which is detrimental to a cane crop.) From various causes, not necessary to mention here, Mr. Wray failed to make sugar and abandoned his seed, as also his patent process, and returned to England disgusted and largely out of pocket Thus much for the history of the only importation of seeds that I have been able to trace back to their nativity.

We see advertised "Otaheitan," which is the name of one of the varieties of a Louisiana cane extensively

cultivated there from planted canes, not seed; another is the Liberian, some call it club-head. This is of Wray's Imphee, Boom-vwa-na, and has maintained its character very distinctly. I can well recollect seeing it in Mr. Wray's hand and took it for a Sumac tuft myself. It is a hardy and good cane, suited to late working, and will make sugar, as will be shown by farmer Schwarz sample.

Here is a few tufts sent from Meridian, Miss., by Mr. Shannon, who calls it Crook Neck Sorghum which evidently is an Imphee, Nee-a-za-na, as will be seen by the engraving in my book, taken fifteen years since. It has somewhat changed in the color and size of the seed and also the stalk, as described to me by Mr. S. who called on me some weeks since. Whether this change is the result of hybrid or cultivation I cannot tell. Mr. S. is an intelligent gentleman and gives it great favor, as will be seen by his communication.

Another mis-named cane is the Honduras. It is a very late cane, at least thirty days later than the Boom-vwa-na or Liberian, and, although a sweet and good cane, it is of doubtful propriety to plant north of Mason and Dixon's Line; it is an Imphee, Vim-bis-chua-pa.

I now come to the variety so widely known as the Early Amber. These tufts are a fair specimen of the various lots that have been sent to this convention. As most of them have been packed in small packages they will hardly show their correct figure when growing. They have a very heavy kernel which, when entirely clean, will weigh fifty-eight pounds per bushel, which corresponds exactly with the Nee-a-za-na as well as the size of the kernel, though not quite as white.

This flower is a sample which has been furnished me by Mr. J. S. Tompkins, now of this city, whose communication and samples of syrup from this cane will attract much interest at the proper time. This Amber Cane has the appearance of being an hybrid in which Nee-a-za-na is a party and either the Chinese or one of the Imphees the other, most probable the former, which accounts for the longer foot-stalks and darker seed, while the large kernel and shorter stalk with earlier maturity attaches to the Nee-a-za-na. But whatever is its origin it matters little, or whether it was crossed in France and brought here by Mr. Teas of Indiana, eighteen years ago, it is all the same. We have it and it is a great boon to us, as by its early maturing it not only facilitates sugar-making but affords us a longer season for working, as it will mature during the warm season which will facilitate the process of granulation in the hands of those working it up with a view to sugar-making. There are other samples of seed that have come to hand, but not possessing qualities to recommend them as equal to those already described. One tuft by mail, apparently an hybrid of either Amber or Nee-a-za-na with Liberian, that may prove a good thing, I shall have it carefully cultivated and report next season.

The great object being to determine the best varieties for sugar-making, as also that of syrup, and plant them in such order as to have them ripen in rotation in order to supply the works for as long a period as possible. That there has been an improvement in these canes since first introduced seems evident, and in this we see our hopes being realized.

I will now appeal to this convention not to close its labors without providing in some manner to further,

and more definitely pursue, a course of improving them until we shall have secured for ourselves and posterity a blessing that shall make us free of all foreign or adulterated products, so that we can say (as our honorable friend that produced this pile of sugar) that, if "our land does not flow with milk and honey, it may with sugar and molasses."

I am not aware that any appropriate, systematic efforts have been made to improve the cane by a careful selection of the seed, and it would be strange indeed if a plant like the cane, brought from another country, and cultivated under circumstances so peculiarly unfavorable, should not deteriorate. Even Indian corn and Irish potatoes are not expected to improve, or even preserve their qualities from year to year, without careful attention to the seed, and a system of reproducing from the best samples.

The most important qualities in the cane are saccharine richness, per centage of juice, large stalk, and early maturity; and these qualities should, as far as possible, be all combined. In every field of cane some stalks ripen earlier, some grow to a greater size, some are more juicy, and some richer in sugar than others. It should be the aim of every planter to select from his growing cane the individual stalks which most fully combine these qualities, and set apart the seeds which they yield for the next season's planting. And this process should be pursued from year to year, always producing the richest, the largest, and the earliest stalks.

In some sections of the country the order of preference will differ from others. In the more northern range, where the seasons are short, seed will be selected with more particular reference to early matur-

ity; where the seasons are longer, prominence may be given to size of stalk, volume, and richness of juice.

In selecting seed stalks from the standing cane, the comparative size and time of maturity will be plainly enough indicated to the eye; but with reference to the other qualities, something more is needed, and it is with reference to these that the most indiffence or negligence has been manifested, In order to test the cane properly, each stalk previously selected with reference to size and maturity, should be separately weighed, and the juice thoroughly expressed. The juice should then be carefully tested by the saccharometer for richness, and accurately weighed for per centage or comparative volume. By these means all the essentia qualities of a good rich cane may be secured, and until they are faithfully employed, complaints about deterioration may be expected.

I have been much surprised at the careless indifference manifested by most farmers in the preservation of their seed. If they were to practice the same slovenish custom with other crops upon their farms, their reputation for agricultural skill and economy would be at a large discount, as well as their financial credit. In my intercourse with them I find but few who even gather their seed for stock-feed; the custom generally being to slash it off, and leave it on the ground to waste, unless, perchance, the field is so circumstanced that hogs or cattle can be turned in. Although this is quite wasteful, neverthless it is preferable to the entire loss. Mr. Wm. Haddax, near Osborn, Ohio, informs me that his hogs never done better upon any feed than upon the cane stubble, with the seed scattered as above.

CHAPTER II.

SOILS AND CULTIVATION.

Embracing also Mr. Ricker's Essay before the Convention, and discussion thereon

There has generally been a greater mistake in the selection of soil than any other feature of this business, mostly growing out of a desire to obtain a large growth, regardless of the quality of the juices.

It is well known that low wet, deep black, or freshly manured lands are productive of rank acid vegetation, whether of fruits, vegetables, or grapes. Stock will shun the vale and nip close the hillside, because of the greatest amount of saccharine and other nutrition; the multiplied testimony is now so great, when added to that of our thorough cultivator and valued pioneer, Mr. Ricker, that it is to be hoped we shall soon get out of that rut of error.

The alluvial fields of Louisiana are free of ammonia but strongly impregnated with the same properties that make the waters of the Missouri river (out of whose deposits they are chiefly made); among these properties magnesia is quite prominent.

Where the soil does not possess lime it should be added either in the form of quick-lime or the sulphates,

common plaster or plaster-paris. I am well satisfied by a long series of observations, that sugar-making from these northern canes will only be made successful by a thorough system of cultivation, by which to produce a *true sugar-cane*, free from the gums and albuminous properties that require chemical solutions and patent processess to counteract their baleful influences upon chrystalization. We have the satisfaction to know that by far the best sugar, and the only specimen from field operations at our late convention, was that of the Honorable Seth H. Kenny of Minnesota, (whose communication will be found in the chapter on sugar-making); he used no chemicals or reagents whatever, hence his cane was rightly conditioned by cultivation; let me, therefore, again strenuously urge the most rigid adherence and attention to the foregoing suggestions.

I here introduce the valuable essay of the Hon. E. S. Ricker of Locust Corners, Ohio:

E. S. RICKER'S ESSAY ON SOIL AND CULTIVATION.

I shall confine my remarks to my own immediate vicinity and the results of my own observation and experience. We have three varieties of soil within the limits of this neighborhood.

First. Ohio river bottom land. Rich for corn, and yields great crops of cane with an abundance of foliage; but the juice is not sweet and syrup not pleasant.

Second. Low lands along our creeks. These bottom lands have often much sand in their composition, and, when so, produce large crops of cane, making fine syrup.

Third. Uplands. My farm is on rolling upland.

originally a deep, virgin soil, with clay subsoil resting on blue limestone. My fields are underdrained with tile from three and a half to four and a half feet under ground. I cultivate crops in rotation; following a cane crop after corn, and the corn after meadow or sod. Thus, in the winter, spread from sixteen to twenty wagon loads of barn-yard manure per acre on the sod, and plow with three horses, nine inches deep. Cut and shock the corn, and expect a yield of seventy-five or more bushels per acre. Let no animals roam over the field to tramp it. and in early spring plow so deep that there will be twelve inches of loose soil. The rotton sod, with the manure, makes the soil mellow as an ash heap, and is the best possible condition that I know how to prepare a field for corn. Now level the field with a drag made of six rails, woven together with two trace chains at about three feet from the ends of the rails. This does not pack the ground as does a roller. Then plant the seed with a drill, dropping about six seeds to the foot, and in rows three and one-half feet apart, the drill doing the work of furrowing, dropping and covering. By the time the seed is well sprouted, go over the field again with the drag; and just about the time the first plants are appearing, drag the rails across the previous dragging. Now we have a fresh, clean, mellow field for the plants to emerge into daylight. As soon as the row of plants can be traced with the eye, with a one-horse plow, with a fender, to keep the dirt from the plants, plow as close to the rows as possible; and one with a steel rake can clear the plants and keep up with the plow. By the time the plants are a finger's length high, scrape the rows with sharp hoes and thin the plants to about three to the foot. If this work ts thoroughly done, then go

about three times, twice in a row each time, with a double-shovel or cultivator, to be completed by the time the cane is four feet high, will be sufficient. Thus prepared and cultivated, I expect a yield of from 165 to 185 gallons of refined syrup, of a density of 42 deg. Baume.

The next most successful way to prepare a field for cane, is to let the aftermath of a clover field remain through the fall and winter untouched until about the tenth of May. By that time the young clover will be well up. Then turn under deeply. Subsoiling would be beneficial in most soils, especially where land is not under-drained. So might irrigation be capital, but only the few can command it. Soaking the seed and rolling in plaster may be advantageous if conditions be right at the time of, and after, planting. Otherwise I never tried it but once. An old clay field with all the organic compounds (the nitrogen, oxygen and carbon, etc.,) so nearly worn and washed out that cane will but feebly or barely grow upon it, will yield the clearest and the finest fruity flavored syrup, but the quantity may not pay for cultivation. On the other hand a field in good heart, freely and freshly manured from the hog pens and horse stables, might give an enormous yield of syrup, but of a quality that would be unfit for the table.

SOILS, AND SEASONS OF PLANTING.

There has been great remissness under this head. Farmers seem to have thought too little of this crop, and hence seldom make a good selection of soil, or give that attention in its preparation that would insure the best results. There is no plant more feeble or sensitive in its early growth than this; therefore, the

selection of soil, as well as its preparation, should receive especial attention. Where it is possible, I would underdrain, and plow very deep; always prefering a clover lair, if possible, or other newly-broken ground to that of fresh-manured land, as it has been repeatedly shown that the cane will partake of the character of the soil. An instance is reported where sulphur and salt was put upon the ground before planting, and the syrup partook of it quite distinctly. A free use of lime or ashes will be found advantageous, especially upon the lower tables of land. These trials should be made and reported for future guidance. I would reccommend planting in a ridge rather than the furrow, as the seed needs the warmth of the sun, and freedom from the cold rains of May, to germinate.

The ground for this crop can not be plowed too deep, as its roots penetrate to a great depth, even as far as three and one-half feet, to which depth I have traced them. As before indicated, I am satisfied that the African cane will stand a much stronger soil than the Chinese.

It would be altogether useless to attempt the naming of any particular date for planting. Seasons differ; and, therefore, I can only say, plant as early as the ground, by being dry and warm, seems fitted for the seed, and then plant shallow—*very* shallow.

The seed should, previous to planting, be soaked in warm water until an appearance of germination is perceived. This, in the Imphee, will require about two days; in the Chinese, nearly six.

It has usually been recommended to plant in rows running north and south; but, from some considerations and facts occuring to me, I am inclined to prefer rows running east and west. The west wind storms

are the most destructive, and a crop planted in rows running in the direction of the winds will, of course, stand much better than one the rows of which are transverse to such a direction. I saw one field this season in which the matter was fairly tested. In the portion planted north and south, the crop was laid prostrate; in that part, on the contrary, wherein the rows ranged east and west, the crop was unmoved.

I would especially caution farmers against planting seed without first having testing its capability of germination; then, having satisfied themselves on that point, let care be taken not to plant too thickly. If planted in rows, they should be fully four feet apart; and if planted in drills, about three or four inches between each seed. A reliable machine planter will pay its extra cost in the end; but however planted, and by whomsoever, I repeat, *plant shallow*—not exceeding one inch deep, and half of that depth would be still better. A wheat drill can be used by stopping of the hoes to set the rows to suit. I would prefer drill planting, and doing it well in clean land; it will be found more convenient for stripping, and give a better yield; Southern cane, of course, is all in drill rows about five feet apart.

Very good syrup is being made from almost every variety of soil, but my own experience is in favor of a rich yellow soil, strongly lime, especially when I designed a rich-flavored syrup, regardless of the color, or the extra labor required to clean the coating from the boilers. Mr. Henry Lesher, near Dayton, planted, of the Imphee, upon a gravelly creek bottom, less than the half of an acre, from which he delivered me eight and one-half tons of the best cane I had the past season, the juices marking as high as 15 deg. Baume.

This cane, however remained in the yard about five weeks, and, when worked, the juice possessed very little of the usual green tint, and scarcely changed the color of the litmus, being nearly free of acid. Soils possessing less lime can be greatly improved by the use of it or house ashes upon the hill during the cultivation.

CHAPTER III.

CULTIVATION OF THE CANE.

Having made a good selection of soil, as indicated in the preceeding chapter, it will be found that in order to place the seed in a position to feel the warmth of the sun, ridge planting will best secure this end. I have found, by passing over the field repeatedly during the early vegetation, that in those hills in a low furrow the seeds were not yet sprouted, while upon the higher position, only three or four feet distant, the young cane was fairly above ground. This led the owner to believe the seed was not good, and hence he proceeded to replant; but, in a few days, the sun shone out with effect, and all the seed came up, but that portion was still behind, and remained so throughout the season. Correct and careful planting is the first important step to insure an early and paying crop. The best results, I believe, have been obtained from planting tolerably thick, say from 8 to 12 seeds to the hill. This tends to prevent tillering, and is believed to hasten the maturity of the crop, as it is the larger stalks that are the latest in maturing. The soil must expend its vegetating energies before the crop can mature.

I would suggest the propriety of an occasional dressing of common plaster, or plaster of Paris, also lime, taking note of its effect with a view to the future; the great object being to counteract the acid so common in the cane, which, if accomplished in its growth, will avoid the necessity of using re-agents in the manufacturing process. Therefore, the use of these fertilizers should not be for the purpose of producing a larger growth, but a better quality of juice; one susceptible of a more ready crystallization. I have not found the custom of hilling around the stalks advantageous. If the ground is kept clean of weeds, and with an ordinary amount of cultivation or small-plow dressing in the early growth, it will be found ample. Late cultivation has a tendency to protract the growth, and stimulate the growth of suckers upon the upper joints of the stalk. It must be borne in mind that no definite rule can be laid down as an infallible guide in the cultivation of any crop; soils and seasons will require a modification of almost every system.

Upon the subject of culture, Mr. Wray says:

"I have in some instances, soaked the seed of the Imphee for twenty-four and even forty-eight hours, in warm water, previous to planting them, in order to expedite their germination, as seeds so treated will, in warm weather, moist weather, be up in four days afterward; whereas, being planted (during showery weather) without this assistance, they usually take six or seven days for sprouting. If, after planting, dry weather sets in, they will, however, require ten or even fourteen days to appear above ground; but by being well soaked beforehand, this causualty is materially obviated. Hence I hold the practice to be a prudent one.

"The seed requires to be very lightly covered; for if deeply set, it is liable to rot, should much cold rain occur immediately after; but lightly covered, it will not be injured by even constant rain.

"I have lost a great deal of seed by planting too deeply, and I shall. therefore, be very cautious never to commit the same error again. If soaked in warm water for twenty-four hours, then planted in a bed, and care taken to keep them properly moist, we may always calculate with certainty on having them an inch above ground in four days (warm weather)."

CHAPTER IV.

CUTTING AND HANDLING.

The season to commence gathering the crop will differ greatly in different localities and different seasons, but, as a general rule, may be set at the first of September, and should be proceeded with expeditiously until the crop is secured from danger of frost. The stripping should not commence until the cane has obtained all the benefits possible upon the hill, as the foliage constitute the channels through which the carbon and oxygen of the atmosphere gain access to the juices of the stalk, whereby its saccharine qualities are elaborated. It is strenuously contended by many, that gathering the cane with the leaves on it, and retaining it thus under shelter for some days, it will improve more rapidly than otherwise. Some favor milling it thus, with the leaves. There would be some loss of juice, but whether enough to overbalance the expense of stripping, is hard to decide. One thing is certain, it should be protected from the storm, as the leaves would soon mold, and impart an unpleasant flavor to the syrup.

The cane, when thus thrown in heaps, or bound in bundles, can be very readily stripped by catching hold of the top end, and drawing the stalks from the heaps, will disengage it from the leaves. But the general method of handling is to strip either by hand, with mittens, or with a pronged stick, similar to a shaking-fork, only much less weighty. The cane should always be bound with two bands, both as a matter of economy in labor as well as a better security from destruction and waste. The wilted leaves serve well for this purpose, binding from thirty to fifty stalks in a bundle. The leaves will become too brittle if not used in a day or two of the time of stripping.

The seed heads together with about two feet of the cane, should be cut off and tied into small bundles with the leaves; they are far better, as food for every kind of stock, than sheaf oats, and are richly worth saving. I am aware of a rumor which has gone abroad, to the effect that they are injurious; and although the statement has a thousand times been refuted, I am still asked whether the seed will not kill cattle and horses. I once lost a valuable horse by feeding to him imprudently a mess of oats, and so, but *only* so, it may be with this seed; yet, according to the proverb, "A lie once started, the truth seldom overtakes it."

I would recommend the use of carts or wagons arranged for dumping, for hauling cane, on account of the convenience of unloading. Having occasion to reload and haul considerable of my cane once, I constructed a tilting-rack, which being placed in the bottom of the wagon, the cane is piled in, butts outward, filling the bed, which would make fully a ton weight in an ordinary sized wagon. By this simple fixture a load may be dropped in a moment, the team

return for another without loss of time, or occupying the yard-room unnecessarily long. Cane should be ricked up either under shelter or in open air, and thus kept for several weeks, it will improve in saccharine richness from one to three degrees, but the ends should be in a dry place.

This improvement takes place upon the same principle and from similar causes which determine the sweetening of acid fruit after pulling, viz: the change of the acid gum and starch into sugar. When chemists shall determine what this acid is and its particular office in the labratory of nature, as performed in the vegetable product, we shall no doubt learn better how to treat it in the growing cane.

If, at any time while the cane is standing, a sharp freeze (not merely a frost) should occur, the whole crop should be slashed down and thrown into wind-rows, with the tops uppermost. If much difficulty should then arise in stripping off the leaves, the canes may be ground with the leaves adhering, but the tops should be freely cut off. All possible dispatch should be used after freezing in getting the canes through the mill, lest a warm sun thould come out and fermentation and souring commence. The frost does no harm of itself, but when the warm weather follows, the mischief is done.

In handling an extensive crop, a dumping wagon will be found highly convenient. In the Southern States they are in common use for the purpose.

CHAPTER V.

ARRANGEMENT OF STEAM SUGAR-WORKS.

In most cases, for some few years to come, steam or even water-power works, for the manufacture of syrup and sugar in the North, will be substituting of steam mills, factories, or shops erected for other purposes. In all such cases, it will require more study and engineering to so arrange the new works in and about the old establishment in such a manner as to make it substantial, and, at the same time, convenient, than it will to plan a full new works. In the latter case, a general plan will answer all parties for works of the same system of operation. For instance, in Louisiana and the West Indies, where steam power is used for grinding, and a fire-train for boiling, you will find no essential difference in all such works. An oblong building, with an engine across one end; next to this is the crushing mill, elevated some twelve or fifteen feet, upon a substantial mason-work or a thorough husk frame; descending from this, on one side, is an endless apron, made of chain links and cross slats. This apron generally extends out of the main building into a cane-shed, sometimes to the distance of one hundred feet upon the level, and of a height suited for receiving the cane from the hand-feeders.

These sheds are usually quite spacious, often two hundred feet square, the apron passing through the center. The cane accumulates on the right and left of these aprons, in enormous heaps, during fair weather, by which they are enabled to continue running during the rainy spells that ofton occur there. These heaps I have seen as high as fifteen feet, and it frequently occurs that the cane first deposited remains until near the close of the season, and yet it receives no apparent injury.

Upon the opposite side of the mill is affixed another apron, for conveying the bagasse to its destination. In many establishments it is passed directly into a furnace situated in front of the steam boilers.

The steam boilers are usually outside, and at right angles with the line of aprons. The juice, from the sink under the mill, is received into vats, of which there are usually three or four, holding about three huudred gallons each, or enough to fill the first kettle or "grand." As soon as one of these tanks are full, the stream is turned into another, the lime is added, to neutralize the free acid present.

The range of kettles (for it is in these that the great mass of sugar is made) consists generally of five, sometimes six, which are positioned upon the sides of the oblong building referred to. These kettles vary in size from eight feet down to about four in diameter, with the latter, called "battery," directly over the fire, and higher, by about six inches, then the next, which is calied "cero;" and thus they increase in size, and lower in the range, until they reach the "grand." The mode of operating is to heat slowly in the "grand," defecate and dip up into the next, called "flambeau," and as the scum is thrown up by the ebullition, it flows

off down into the "grand," and as the next kettle, called "prop," needs filling, a portion of its contents are passed up, and thus on up to the battery, the scum flowing or being swept off down until it reaches the "grand," and there being diluted with the juice, is removed with a skimmer. The dipping is performed with a large wooden ladle, strongly made, with a pole inserted in an inclined position, and operated similar to sculling a boat, by breaking over the breastwork surrounding the kettles. The intensity of the heat, as the syrup increases in density and approaches the hottest part of the train, causes the most violent commotion, which is, to the operators, pleasing, and evidence to them of good results. I deem it useful thus fully to explain this process, as it is the result of a century of experience, and an approximation at least to this plan may yet prove well adapted to larger works in the North. Dr. Leacock, near Baton Rouge, informed me that he had cultivated the Chinese cane, and made an admirable syrup in his fire-train, but could not obtain crystallization satisfactorily. Mr. Geo. Walker, of Macon, Georgia, exhibited at the United States Fair at Louisville, in the year 1857, a sample made by his negroes in a range of kettles the same as used by him for boiling the southern cane juice, receiving the same treatment, and resulting in an article quite as good for syrup purposes as the southern cane. It is but seldom that I have found a better article than he exhibited on that occasion.

In erecting new works, or converting other establishments into sugar works, where the circumstances will not admit of an elevation of the mill, a pump, of large caliber and slow motion, may be used for elevating the juice, as indicated in the description of my former

works, in another part of this chapter. My mill, conconstructed with a large master-roll, and the two lower ones less in diameter, enabled me to feed upon an apron running upon a horizontal plane, with a falling roll, (directly above the roll that propels the apron,) whose weight is sufficient to inforce a steady feed, as presented by the feeder upon the apron. It will be found very essential to have both cane and bagass aprons to all mills doing business of any great magnitude; they secure more regular feed, and stimulate the workmen to more active exertions, by which they are more likely to earn their wages. In the disposition of the bagasse it is quite important to have an apron, as by it the continued stream may be elevated either to the furnace, or piled upon a tilting platform, from which a cart or wagon can be filled in a moment by a mere boy of twelve years.

There is a new malleable chain being made which will suit to making such aprons as well as propelling them. The cane and bagasse apron must be propelled by the gearing of the mill, as it has much more to do, and should not fail to run while the mill is motion.

The attention of the reader is directed to the plan as represented on another page of this work. I have endeavored to get the artist to give a bird's-eye view of a steam works as I would build for myself, were I to undertake a permanent establishment. The arrangement of smaller establishment will, for some years yet, occupy the cheif attention of those engaging in this enterprise. The business being a new one, each year enlists a new army of beginners; it is, therefore, important, in a work like this, to treat the subject as though it was just being introduced, with this difference, that we can caution new beginners against the

misfortunes encountered by the pioneers in the business. The most simple, and, at the same time, substantial works, employing the power of two horses at a time, will be found most economical, all things considered. In such case, I would recommend a vertical mill, with rolls of fifteen or twenty inches diameter. I have found that an increase of diameter facilitates the feeding, enables you to use a longer lever, giving more room for handling the cane within the circle described by the horses. It is highly important to be provided with more mill capacity than evaporating, for it is quite easy to stop the former, while the furnace, once heated, should be kept supplied; besides it will ever be found that a keen draft and a brisk fire are essential to good, rich-flavored syrups. Upon this subject I shall be more explicit when discussing Evaporation, etc.

I have intimated that two horses were best suited for the smaller works. I do it—for it is quite difficult to keep two teams, either of one horse each, or two in span, at work together, especially upon a sugar-mill, where the driver can not occupy a center position, as, for instance, upon a threshing power. The draft is a dead one, and the mill being quite noiseless, one team may slack up, leaving the whole draft upon the other, unless more closely watched than is convenient at all times.

Although most of the works on a small scale are in the open air, it is not advisable to have them so. Open sheds will do tolerably well for the mill, but close building are decidedly preferable for boiling works, more particularly so where night-work beomes necessary; in fact, it is essentially requisite, as the least

current of air drifts the stream upon the lights, and smothers them, or blinds the workman, by which he is liable to mistake his work.

Seeing that the cultivation of the Nortnern cane, and the manufacture of syrup and sugar therefrom has now become in the North a settled matter, we are met by the very legitimate inquiry, 'Will it pay?' and if so, in what manner shall the procedure be arranged and conducted? In reply, it may be affirmed that it can only be made to pay when conducted in a well-arranged establishment, according to a good method or system. The cane possesses in its juice an amount and quality of saccharine matter not equaled even by the sugar tree; it needs only to be purged of all offensive matters to insure its finding a ready market, and taking the place, not only of ordinary molasses, but also of the choicer syrups.

As I have elsewhere previously intimated, the apparatus and establishment generally should be of sufficient magnitude to give as full employment to each person engaged, as they would have when employed in the harvest-field. This is an all important consideration, and even should it require the concentration of the surplus capital in a neighborhood to establish and carry on such works, it had better be done, than that a number of diminutive establishments should be started, to prove so many failures.

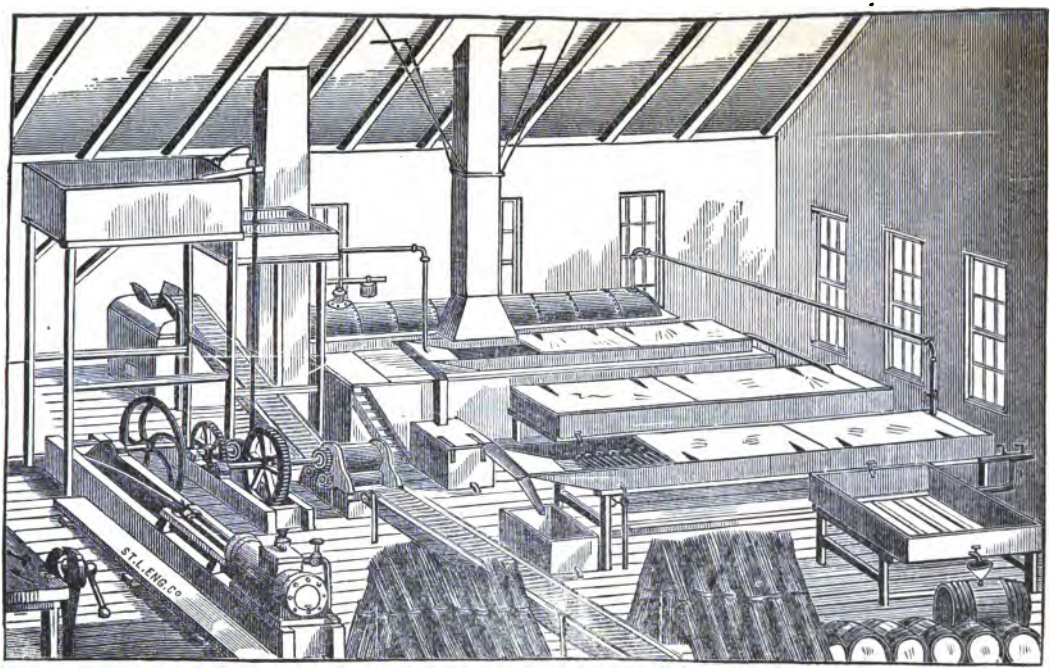
In nearly every settlement of medium magnitude, there is to be found a stream of running water, or idle steam power, which, for two months in the year, can be applicable to the propulsion of the crushing machinery; where, however, such a stream is not conveniently applied, the mill may be worked by four, or even two horses. The former will supply enough juice for

nearly three hundred gallons of syrup per day; the latter for about one hundred and twenty; a one-horse mill I should consider to be but a throwing away of money.

In the selection of a site for the erection of a large establishment it is well, if possible, to secure an abrupt bank, of say ten or fifteen feet in height, for the situation of the crushing mill. This will save the labor of elevating either the cane or the juice, and the fall here indicated will be all required for passing the juice into the barrels or tanks. In Louisiana this arrangement is very common, and should always, when possible, be secured.

As to the extent of ground required, I should say two acres would be sufficient for cane and sheds. The mill-house should be situated at one end of the cane yard, with about fifty feet of endless apron, running back therefrom into the yard. At each side of this endless feeding apron the cane may be ricked up at right angles, a narrow passage only being left for a feeder to walk in between the ricks. The cane ricks may extend fifty or more feet each way, and it will be found much better thus to set the cane on end than to pile it horizontally, for in the former method of arranging it, should a freeze occur, it catches only the outer bundles; these can soon be worked up, and no harm be done.

The building, may be built about sixty feet by forty, and about twenty feet high to the eaves. It is, likewise, well to provide a large tank, or reservoir, wherein, by having a mill of large enough powers, a supply of juice can be stored during the daylight for boiling at night by artificial light. Thus provided, the yard and mill may be closed up at dark, and the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operations by night rendered more simple and economical. It will be found here, as in all other works where large fires are required, exceedingly wasteful to suspend the works during the night, as the walls of the furnaces, having a great capacity for caloric, are long in heating up, and hence, when once heated, should be kept from cooling off.

In situations where it is impossible to have the mill set upon an eminence, as heretofore indicated, it should either be elevated on masonry, or framework of sufficient strength, in which case the cane will require to be elevated on inclined aprons; or the mill should be set over a sunken cistern, into which the juice can run, and from whence it may be elevated by pumps to a reservoir placed at a convenient height. My own works in psst seasons, were constructed on the last-mentioned plan; the cistern below the mill was of the capacity of three hundred and fifty gallons, and the reservoir of twenty-five hundred gallons, both being constructed of one-and-a-half inch seasoned pine, well painted with red lead and boiled oil, thoroughly clamped, and they were found to be very close and serviceable. The pumps for elevating the juice from the cistern to the reservoir should be constructed of large bore, if circular, at least four inches in diameter, of firm and sound timber or iron. They should be operated slowly, the motions of the piston not exceeding twenty per minute; when they are operated quickly the juice is found to foam, and this, in warm weather, is apt to hasten fermentation.

In making the calculations for height, or elevation of reservoir, we must consider the number and positions of the various vessels through which the juice must pass before reaching the barrels in the form of syrup.

Beginning, then, with the 'grand' which may be situated on a level immediately below that of the reservoir; from the 'grand,' after boiling, the juice is run off into a subsiding or precipitating tank, which I shall name the 'prop;' from the 'prop,' the juice, after subsiding, is run into the 'strike,' or battery; after the syrup has reached the requisite degree of concentration in the 'strike,' it should be *quickly* run off by large gates into a shallow 'cooler,' of, say, ten inches depth, and thirty or forty feet of surface; as soon as the syrup in the cooler has reached a temperature of, say, 130° Fahr., it may be run off into casks, by means of a funnel. Commencing, therefore, with the height of a cask, with a funnel in it, we must add the height of the cooler, then the height of the strike, to this the height of the precipitating tank, and lastly, adding the height of the grand, we shall arrive at the proper elevation of the floor of the reservoir. Of course, we shall, in each case, add a little for fall or draw-off. In approximate numbers, the battery, where steam is used, should be twenty inches; prop, fifteen; grand, eighteen; and reservoir, thirty or more inches.

As regards the disposal of the skimmings, which, by the way, are much too valuable to be thrown away, I shall speak in another part of this work. Here, however, it will be proper to say, that a suitable tank should be provided wherein to collect them as they are removed from the various pans.

By means of chimneys, or flues, made of common board, and arranged over the various pans, leading off through the roof, I was enabled to conduct off the greater portion of the steam, and thus prevent its diffusion throughout the whole atmosphere of the works.

It is very desirable to have, besides the conveniences

already enumerated, suitable sheds for storing the cane in; by such an arrangement the working season may be prolonged into the month of January.

Where horse power is used for crushing, it is well if the mill can be set on an elevation, as before explained with horses below; failing this, pipes of tin or other metal should be laid under the track to conduct the juice into a tank, whence it may be elevated by pumps, etc., as before described. In all cases, both in large and small establishments, care should be taken to plan everything in such a manner as that no hindance to one part shall result from a failure in the other, and thus lead to a multiplication of the stoppage into the number of processes or hands employed.

For a further discussion of steam works, see cut on the next page, with accompanying explanations.

I have received several letters upon the subject of larger works, hence I have obtained the best engraving I could to represent, upon so small a page, in one view, an establishment with an engine, one steam boiler, a three-roller mill, level cane apron, an apron elevating bagasse to a burner in front of the steam boiler, together with a fire-pan and steam-strike, etc., etc. The necessity for making all parts small, in order to get them positioned correctly upon one page of this size, has rendered the custom of lettering upon face of the cut injudicious, tending to confuse the view; but, if the reader has only a limited knowledge of mechanical terms and forms, he will be enabled to follow me through the explanations of the whole arrangement, and the mode of operating it.

At the left hand, in the foreground, will be seen the engine with connection, by cog-gearing, up to the mill; upon the right of the engine, in front of the mill, is the

cane apron passing between the first of a series of cane ricks out into the shed; these ricks, as previously described, may be of thirty feet or more in length, running at right angles, with the apron appearing in form of platoons, about twelve feet from center to center. The posts for these must be set very firmly, and a strong pole or plank, forming the bearer, thoroughly attached, the latter about five feet high. If not well adjusted, and the cane taken from one side, the rick will be forced over by the great weight of the opposite incline. Beyond the mill will be observed the bagasse apron, ascending to the top of the burner, which latter is arranged with a set of cast plates, so balanced that, when empty, they close, shutting the opening to the burner, but as soon as an accumulation of some few pounds of bagasse has fallen in between the inclined plates, they are forced open, and it drops into the furnace, the plates, by their own weight, fall together again, closing the furnace.

We have found it difficult to arrange the drawing so as to give a full view of this furnace. The reservior is elevated somewhat more than called for in actual use, in order to allow a view of the furnace through under it.

The tank, or sunken cistern, into which the juice flows from the mill, is not in view, but is situated between the mill-frame and the framework of the gearing; in this is stationed a pump, operated by a crank upon the end of the shaft, intermediate between the engine shaft and master-wheel shaft; by this the juice is elevated, as fast as expressed, into the main reservior, which, as has been elsewhere intimated, should be competent to hold enough to serve for several hours' run, and in order to guard against a deficiency, in

case of accident to the mill, it may be found better to always have some few hundred gallons on hand, as it is not only wasteful to dampen out fires, but destructive to a furnace; hence, if a mill has, as it should always have, an extra capacity over the evaporating department, there will be no difficulty of keeping juice enough ahead to allow the mill to stop for any little repair or change that is quite liable to occur. There is another condition that may demand this feature. I found it much more convenient to boil at night than to grind; therefore, I required a mill of extra capacity, and a spacious reservoir, to contain a considerable stock ahead. The damage sustained by retaining juice on hand for a few hours is more than compensated for in the above considerations; but there is still another quite as important, that is, in each instance of stopping and starting, there is invariably a considerable loss both in quantity and quality of syrup or sugar made.

To the right of this, and immediately below, are the two tempering tanks, with large gates opening into them from the reservoir. These gates may be simply round holes, about six inches in diameter, closed with a conical plug of some soft wood. The necessity for two tempering tanks will be fully discussed in another chapter, under the head of Neutralizing Re-agents.

Next in the train is the fire-pan, unless a steam defecator is introduced, in which case it would have to come in between these tanks and the pan, and require a receiver below it into which to strike the batches when defecated; then the supply for the fire-pan would come from it, instead of the tempering tanks, as represented in the plan under consideration. The fire-pan represents one I used, which was twenty-five feet long, upon the fire, by thirty-six inches in width, and four-

teen inches deep, entirely of iron. The bottom was scant an eighth of an inch in thickness, but should have been thicker; the sides were a sixteenth, and well riveted, which answered the purpose well; the one end sloped, to accommodate the removal of the scum; the opposite end, over the fire, has an opening or gate through which the syrup is discharged, this end of the pan being about one inch the lowest. I covered this with light sheet-iron lids, supported with wood frames; these I found to increase the ebullition, and considerably facilitate the defecation, by hastening the scum to the back end of the pan, where the juice was admitted

The furnace to this pan I designate as ranging along side the steam-boiler furnace, with the flue passing into the same stack. The position of the operator, when removing the scum, will be at the slope-end of the pan, near the stack, where, with a simple light scraper, he will draw the scum up the incline into the cross trough that conveys it into the covered tank at his right. This tank may be of good dry plank, but thoroughly made and painted. with draw-off gate, about one-and-a-half inches from the bottom. Its capacity should be about two hundred gallons for a works making five hundred gallons per day, and it should be decanted or racked off every ten hours, and there will be found at least sixty per cent. of its contents good, clear juice, which should be returned to the pan. The residue, in the scum tank, struck off through another outlet in the bottom, may be used as described in a succeeding chapter.

At the termination of the lids, some four or five feet from the back end, there is represented a chimney, that conveys the steam out through the roof. This

should be made of light boards, and come down to within about ten or twelve inches of the pan, and close to the lids, allowing only room for the latter to pass up in opening. This disposition of the steam will be found quite a convenience, especially at night, or in cool weather.

I allow a steady flow through this pan, generally obtaining on inspissation to about 18° B., the "cero" passing into a settling tank that I denominate "prop;" the prop lids to shut close, and in capacity should hold some four or six hundred gallons, as the extent of the works may demand; the importance of capacity being to retain sufficient on hand at all times, to avoid the necessity of drawing so low as to disturb the settling, except occasionally, when it has become filled up too much to be convenient for use. The prop should be made of heavy sheet-iron, like the pan, and protected frow the air by being inclosed in a wooden tank. It can be made of thoroughly-seasoned, clear, white pine, but will require the best workmanship and thorough griping, by which it can be closed up as it shrinks, for the hot syrup will contract the plank very much. If made of plank, I would use two of them, side by side, and no wider than one plank, and one deep, with the grain of the wood in the end piece running up and down, so that it would shrink with the bottom; thus made, of two inch plank, and thoroughly painted with red lead and boiled oil, it will serve a good purpose. The draw-off gate should be arranged to draw from the top as represented in the cut.

The settlings of the prop should be discharged into a tank of some four feet in depth, that may stand under one end of it, and to this add about an equal quantity of hot water, (which can be taken from the waste-pipe

of the steam-pan or strike,) which, being well stirred, it will settle in a few hours, when the greater part of the saccharine can be drawn off from the top, having first removed whatever scum is floating. In this and the two scum-tanks enough syrup can be saved to pay the wages of five men, and, if made altogether in one batch, even if of inferior quality, it will justify, as there will always be a demand for a cheap artlcle. See chapter on Products and Markets.

The next in the train is the strike, positioned parallel to the prop, and sufficiently distant from it to admit of the workman passing to and fro during working hours. The dimensions of this, like the preceeding parts of the apparatus, will depend upon the extent of the business to be done. The strike that I have used in past seasons, consists of one hundred and eight feet of one-and-three-quarter inch (external diameter) brass tubing, connected with brass return-bands. The space between the pipes is one-and-a-half inches. The steam entering at the head of the pan, and crossing back and forth untll it reaches the foot, its greatest effect is produced at the entrance, which, like the fire-pan, causes the greater ebullition at that end, and thus drifts whatever of scum there may rise to the sloping end, where the workman stands to remove it.

In operating, the steam can be let on as soon as enough has been let in from the prop to cover the pipes, and a moderate supply of steam until the first scum is removed; then the steam should be increased, and a supply of "cero," from the prop, about equal to the evaporation, until enough is received to make a batch of the desired quantity—say thirty, forty, or more, gallons. Then the inlet is closed, and the batch well tested, to see that it is free from the herbaceous

flavor; if not, add lime-water, to effect that object. It will be found that an active boiling can not well ensue except there is a pressure of steam maintained, at least of seventy-five pounds. A good, reliable steam guage is always a useful appendage to a steam boiler, but in this business it becomes indispensible, as the frequent closing and opening of the valves, in boiling syrup, will require such a monitor constantly on duty. In fact, this business will be more safely and economically managed with a considerable excess of steam-generating capacity, so that these changes may produce less immediate effect, thus affording the engineer more room for managing his fires.

But to return to the train again. The batch being all right as to flavor, the boiling is urged up with full valve, and the operator now watches close by eye, if sufficiently practiced, if not, by the test-cup and saccharometer, until the degree is obtained for syrup; about 36° with some saccharometers; with others, 35° is sufficient. When at this degree of heat, I find some little difference in them, hence it will be well to test them by cooling some of the syrup after being tried by the saccharometer, and settle the guage. As soon as the proper degree is obtained, the steam is closed off, the gate opened, and the batch struck off into the cooler.

The strike, or pan, should be made similar to the fire-pan, (only some ten inches deeper,) of iron, and well riveted; the heat is too great for wood, and will ever prove a source of trouble and loss, if made of it. This pan, as well as the sides of the fire-pan, should be inclosed with plank, which will protect them from the atmosphere, and increase the effect of the heat. This I would cover with lids also, and arrange a steam chimney like the former. It has been left out in the

engraving, because of its covering the view of several parts desirable to be shown. The outlet into the cooler should be directly through the bottom, and at least five inches in diameter, in order to discharge the batch in the least possible time, as the steam has to be retained during the time. In order to facilitate the discharge the strike should be arranged with a convenience for lowering the end some two inches during the time of running off.

The cooler, in the foreground, does not occupy exactly the position it should, owing to the want of room within the limits of the page. It should stand close to the end, and pass under the strike some two feet, in order to receive the batch. The cooler should be in two apartments, each of capacity for holding nearly half a day's run, and not be over twelve inches in depth of syrup. By being in two apartments, one could be cooling and racked off while the other is receiving. This, like the other pans or tanks receiving hot syrup, should be metallic, and riveted, but if properly supported upon a framework, would not require iron over one-sixteenth of an inch in thickness. Iron will serve better for a cooler than a wooden structure, as, being thin, and a good conductor of heat, it will greatly facilitate the cooling.

NOTE.—Molasses barrels should have sixteen good hoops, and the heads of pine, or a center strip of it, at least. Inferior cooperage will injure the market for syrup or molasses very much.

CHAPTER VI.

MILLS AND CANE GRINDING.

As indicated in the preceding chapter, the peculiar construction of mills for expressing the juice will depend very much upon the character of business to be done, whether of steam or horse power. For the former, the rolls should be horizontal, of size and length according to the extent of business to be done; but rolls of less diameter than eighteen inches, will be found difficult to feed, especially from a rolling apron. If feed by hand, they will be found better to have them large, otherwise the butts of large cane will not enter, and a loss of juice will occur, by a thin layer of half-pressed cane passing off. I have proven, to my full satisfaction, that large, short rolls are preferable to small, long ones. There is less danger of breakage, as a more steady feed may be kept up. As about a fair scale of sizes for power mills, I would indicate a master-roll of twenty or twenty-four inches diameter, with the lower rolls fourteen or sixteen inches in diameter; and if twenty-four inches in length, with four revolutions per minute as the maximum speed, and

fed with a layer of cane consisting of about seventy-five stalks, as an average, the yield of about fifteen gallons of juice per minute will be the result. The rolls of such a mill, in order to sustain the pressure, should have a shaft in the master-roll at least five inches in diameter, of the best charcoal iron, and in the lower rolls, four inches, of similar iron. The journal boxes or bearings, should be at least six inches long, and of the most complete fitting. The metal the most common in the boxes of the large mills of the South is a composition of brass, called gun-metal, and this often Babbited by drilling holes, quite numerously, in the bearing circle, and filling them with Babbit-metal. I found cast-iron boxes, bored out and filled in like manner, to serve a good purpose. I have also used chilled hot-blast cast-iron boxes, polished with emory rollers; with these I had some little trouble, arising from the lack of a pefect fit. The pressure is very great, and if there is not a perfect fit, no amount of oil can arrest the friction and wear. A limpid oil is best for such bearings; lard, tallow, or any ordinary grease is not sufficiently fluid. The juice of the cane or water I have found as good as oil, but more difficult to be retained upon the journal. If, by any arrangement, a supply can be kept on, it will answer admirably.

The housings of such mills are difficult to specify, but those making them should not be too sparing of iron; a few pounds more may save a break down. The weight of one, for such a sized mill, will be about four hundred pounds, which, if well proportioned, will stand the lest. My through-bolts were one-and-a-quarter inch charcoal iron; they stood the test, but I feared them continually, and would recommend larger. The timbers upon which the mill stands should be well

seasoned and free from shakes, and of hard wood, as the plates below, through which the thorough-bolts pass, and against which they are pressed by the force of the pressure in the mill, would be directly sunken into any soft timber, and require constant tightening; besides the casting would be endangered. I broke a housing in consequence of shaky timber.

The gearing, for propelling this class of mills, requires great strength and exact fitting. The shaft of the main wheel should be quite as large as that of the master-roll, and the couplings, connecting the gear to the mill, should be very heavy, especially those that are bored and keyed. I burst several in past seasons, and one that had stood through a previous season's work. This, however, is in conformity to a well established fact, viz : that all materials, under great stress, will ultimately fail; hence, for permanency, such parts should possess a superabundance of strength. Mills of this class, of the ordinary construction, require an intermediate coupling-shaft between the main wheel and the master-roll, in order that any irregularity in the movements of the roll shall not disturb the line of the gearing, which would be liable to break while under such strain.

When steam power is applied from a short-stroke engine, and, consequently, quick motion, it would require a very large master-wheel and small pinion to reduce the motion; hence it is found more convenient and cheap to double the back gear than use such a cumbersome wheel. An engine, eight-inch cylinder, two-foot stroke, being about suited for this purpose, should make nearly one hundred revolutions per minute, with eighty pounds of steam. In order to reduce this motion, one pair of gear, reducing four times, and

another, six times, will accomplish the object. Ordinary gear-wheel are not well proportioned for strength to answer this purpose. I would suggest to those making patterns for this purpose, to make their master-wheel about five feet in diameter, with two inch pitch and four inch face, a pinion of about ten inches diameter, with shrouded cogs. This size would serve well, single, for the lesser mills, and by hanging two of them side by side, on the same shaft, will answer for the large mill, as described above. In the next gear the same pinion may be used, and a wheel of about forty inches diameter and three inch face. The rim and arms should be made to embrace strength, and such proportion as to avoid strain by shrinkage. Crooked arms are always preferable on this account.

The first gear is sometimes by belting; in such case it will require a large band-wheel and heavy belt—the former some ten feet in diameter, and the latter twelve inches wide, kept in active service by a tightening pulley. This method of propelling is more advisable where hand feeding is relied upon, as, in such cases, it is not unfrequent that the mill is over-fed, and then the belt may serve as a safety-valve, although it is likely to receive some damage by being cast off while running.

The use of flanges upon the ends of the lower rolls I found to serve a good purpose, until, by a mishap in not getting oil to one of the journals, on a cold night, the box cut away, letting the end of the roll settle, thereby cramping the flange, which broke one off. This is, therefore, a demonstration of the importance of a oorrect adjustment and more careful working of the machinery where flanges are used. The dumb returner must fit between the flanges, as, under such

pressure, the hard shell of the cane will insert and increase the friction greatly.

The custom of casting rolls upon the shafts I find to answer quite as well, or better, than boring and keying. Long cylinders, having heads every four or five inches, extending to the shafts, will give great security to the shell of the roll without necessitating so great a thickness of metal forming the shell. With these supports, one-and-aquarter inches of strong iron will be found an ample thickness.

I would suggest a plan of mill that may be considerably cheaper, and, at the same time, quite an effective mill, viz.: a two-roller mill, with one roll directly above the other—rolls of equal size, with the crown-gear, on one end, and the master-wheel keyed directly upon the shaft of the opposite end of the lower roll, which, in such an arrangement, turns in a stationary box; hence this gear may be attached to it with safety.

Manufacturers must be very particular in so adjusting the size of the rolls, and the pitch of the gearing that there shall not be the least variation in their movement; for instance, if one roll is less than the circle of the pitch of the gear, as compared with the other roll. it will be compelled to slip enough to increase its circumference to equal the other, which will cause great strains upon the gear, and consequent tax of power upon the team or engine.

Two-roll mills have done good execution, and, no doubt, will work with less power, as the friction of the dumb return is avoided, as well as one pair of gear and journals.

It is generally believed that it takes less power to

crush a given quantity of cane, in a given time, with small rolls, than it does with large ones. This I consider a mistake; although the point of resistance is extended, yet the greater ease with which an obstacle is surmounted by a larger wheel, over the lesser, is fully compensated for, and then the extent of the impingement of the large rolls is much more, by which the juice is expelled with less liability to cut the cane. It will be recollected that the surface of the rolls should have about the same speed in all cases.

I have one more suggestion to offer, as an improvement, by which the saccharine property can be more fully extracted, hoping some person may put the matter to a test, viz : the construction of a double mill, with two pair of rolls, as just described, set some three feet apart—the last pair about six inches lower, with a steam-chest between them, through which the bagasse is to pass, subjected to the constant puffing of the exhaust steam of the engine.* This, I believe, will soften the fiber, and, of course, dilute the sweet remaining in the bagasse by the condensation of the steam, which, by the second pressure, will be extracted, and the saccharine thus obtained fully compensate for the expense attending the operation.

This matter will appear more important when we estimate the quantity of saccharine left in the bagasse, even that the most thoroughly milled. There are very few mills in the North that take out to exceed sixty pounds of every hundred weight of cane, while the

*NOTE —This feature of a mill was suggested by a distinguished speaker in our late Convention, without quoting the fact of its having been in my book of 1863, from which this is now copied.

bagasse, dried in the sun, will weigh less than twenty pounds, leaving, consequently, twenty pounds of juice, or four hundred to each ton; or, in other words, enough to make five gallons of syrup; and in an ordinary yield of cane, say twelve tons per acre, the gain over the present yield would be sixty gallons. The only expense attending this would be in some little additional outlay in mill, and some extra fuel in evaporating the water added to the juice by the condensed steam upon the bagasse.

As this business becomes more settled and general, the competition in the market will make it important to adopt every possible plan of economy by which not only to save labor, but to make the greatest possible yield from a crop once produced; for all the various handlings and expense of its production, and milling, etc., are the same, whether the one-half or all the value it possesses is obtained. In the great sugar districts of the South as also of the West Indies, the planter does not hesitate to invest five or ten thousand dollars, if, by so doing, he can even increase the amount of crystallization a few pounds to the hundred, or improve the quality of his sugar so as to realize a quarter of a cent more per pound. Thus must it be with us in this crop. If, by any improvement, we can make a syrup that will bring five cents more per gallon, the result, in making ten thousand gallons, will be five hundred dollars, and so on for every subsequent ten thousand; or, in a saving of only ten per cent. in making ten thousand gallons, it will amount to an aggregate of one thousand gallons.

I introduce these considerations with a view of stimulating the minds of those in every department of this business to improvement and progress. The present

high prices can not be expected to continue long, and, unless we succeed in adopting some system by which we can produce this syrup and sugar upon a scale that will compete with the products of the tropical plant, it must dwindle away, instead of growing, as it should, into great commercial importance.

When our manufacturers of apparatus fully understand their business, it will be found most prudent for those engaging in this syrup and sugar enterprise, to simply apply for a set of fixtures to do a certain amount of business of a certain class; that is, steam or horse power, fire or steam boiling, as the case may be, and thus throw all the responsibility upon the machinery manufacturer; otherwise obtain the plans and specifications of some experienced operator, and then get them executed at the best rates. This is the plan generally adopted South, and, no doubt, will ultimately be adopted with us. If I had to have a limb amputated, I should certainly want to employ an expert surgeon of practice.

Those designing erecting works should, by all means, arrange for their mills and other fixtures long in advance of the working season—a month or two is not sufficient; manufacturers must have time to prepare; besides, such work, rushed out in haste, is liable to be imperfectly done.

Another consideration presents itself, quite important to the purchaser. Manufacturers can furnish such work for a less per cent. profit, upon well-secured contract, than when made upon a speculative estimate of the demand. Contracts for an outfit for a southern works are usually eight or ten months in advance. Farmers should determine their purposes in regard to this crop, as well as all others, and then set about

arranging for carrying out their plans. A man that should plant fifty or a hundred acres of cane, without knowing positively how it is to be worked up, would be considered as a fit subject for a lunatic asylum, or, in other words, would be very much like the man who had raffled and won the elephant. This is a new business in our country, and needs systematising, in order to become successful.

The next class of mills demanding attention, is of medium size, between those already described and the common two-horse mill, and is sometimes of horizontal rolls, and, at others, vertical, calculated for four, six, or eight horses. Now, the strength and adjustment of the gearing to propel such mills by power so irregularly exerted as that of horses, mules, or cattle, is seldom sufficiently considered. The ordinary power exerted by a span of horses upon a steady pull, is three hundred and fifty pounds, as indicated by the dynamometer; but, when excited by the lash, I have seen it run up to nine hundred; hence, with four span, an excess of twenty-two hundred pounds is frequently thrown upon the gearing, which, if not well fortified, must fail. Where the line of motion is changed, by the introduction of a bevel or miter-gear, the liabilities to breakage are greatly increased over that of the simple speer-gearing. It requires the best seasoned oak or other hard timber, of good, ample proportion, and thoroughly framed, to form a husk frame-work for such gearing, and then it must be so firmly braced that it can not be made to give a particle by the most violent effort of the whole combined force employed.

There may be much damage sustained, even without a breakage, by waste of power, when the shafting and gear become even sligtly disturbed. In my obser-

vation and experience, large mills, propelled by animal power, never accomplished work in an increased ratio with the increase of animals employed. This, however, in a great measure, may be accounted for in the fact that it is difficult to keep the animals all uniformly employed; nevertheless, whatever of loss is sustained thereby is fully compensated for by the saving in hand-labor, as it only requires a man to feed a large mill, and one, however small, will require a hand; but the economy of labor does not end here, as is shown in the discussion of the combined steam and fire-train, as illustrated in the preceding chapter.

It will be found necessary to an economical system of working, to adopt the use of cane and bagasse aprons, not only on account of a saving of labor, but as a relief from the liability to interruption from the absence of hands in sickness or caprice. In this business, as in the harvest-field, it is found better to use a self-binder, though it cost much more than a self-rake, as by it you are independent of the contingency above referred to.

Although I am partial to vertical mills with large rolls, still the horizontal is best suited to the use of the aprons, especially a feed or cane apron. The use of a windlass or drum, propelled by the master-roll of the vertical mill, so arranged that it could be clutched by the hand of the feeder, and wind up a truck load of cane to the mill, and the truck so constructed as to tilt sideways and unload by the feeder, and then, by loosing the lock of the drum, the truck would run back down the inclined ways for re-loading. Such an arrangement would be an economy, as the loading could be done by a cheaper and single hand.

Another plan for employing a truck to a mill set upon the level, would be to use a larger sized mill, of ample

strength, and attach a long lever, say fifteen feet or more, which will afford room for a track near the level of the ground, upon which a load of cane can be run in and tilted and backed out at the next round of the horses. In all cases of mills above one-horse power some such facilities are requisite to ensure expedition.

If the cane has been bound in bundles, as elsewhere intimated, the handling will be greatly facilitated, beside preventing much waste of cane. All of my cane for a large works for two years were bound, out of choice, by those delivering it.

I repeat, that it will be found comparatively unprofitable to work a mill of less capacity than two horses, and still more profitable the larger the mill, provided all things in connection are correspondingly complete.

This can only be secured by such an arrangement of a train and furnace that a steady application of heat may be obtained and sustained; the pans so constructed that the juice may be advanced to the higher heat, and the scum allowed to flow back and be taken off at the cooler end of the pan. It is a well-settled fact that the more concentrated the syrup becomes, the more rapid must be the boiling, until completed. The use of defecators cannot be dispensed with, and are the first point where heat is applied, and, if made judiciously, will insure good results. The juice having been treated with lime and allowed a few minutes to settle, all the earthy matter, together with such particles of the lime as are not taken up by the acid reaction, will precipitate and may be removed after the batch has been drawn off by swing pipe. This may secure the same result that is obtained by the use of settling tank without the losses consequent thereon.

CHAPTER VII.

DEFECATING AND NEUTRALIZING.

In all large works it will be found advisable to provide especially for defecating the juice, by the arrangement of some suitable pan, in such manner that the heat (either fire or steam) can be under immediate control; and, furthermore, as herein is the great bulk of labor in skimming, therefore a conveniently constructed apparatus, from which the scum can be removed with certainty and but little labor. The method of removing it is with a perforated skimmer, as is done in Louisiana and Cuba, from the large kettles, is very laborious, and not so complete as other methods that may be suggested.

Whatever form of vessel is used for a defecator, it should be well arranged for cleaning, as there must, of necessity, be a constant accumulation, upon its sides and bottom, of the neutral salts, together with the heavier substances contained in the juice. The use of coil pipes, as described in the preceding chapter, are quite common, and would answer a good purpose, were it not for the great trouble of cleaning them, the

necessity for which I will illustrate by giving here a statement of the effect of using my defecator some three days without cleaning the pipes.

It took thirty minutes to obtain a temperature (190°) suited to the removal of the first blanket of scum; but the next day, having cleaned my coil, the above degree of heat was obtained, with the same pressure of steam, in ten minutes; this led me to notice more particularly the operation of my steam boiler, for we were much retarded by the want of steam, although our fireman used every possible means to keep up a supply. We then stopped, and had it cleaned, when an equally favorable result followed. This is no new thing, of course, but I refer to it only with a view to show the importance of so arranging a steam works as to condense all the steam and to re-use it in the boilers, for having been once evaporated, it will thereafter make little or no deposit.

There are several plans for constructing a steam defecator free from the objections of a coil, and, at the same time, possessing all of its advantages. An oblong steam-jacket with the lower surface protected from the the atmosphere, in order to avoid the condensation that would be caused by its contact. It may be set in a flue, (where a fire-pan is employed in the train,) between it and the stack, and sufficiently elevated to draw it from the latter. This defecator should be made quite smooth inside; whatever rivets or bolts are in it, should be countersunk, and if the iron is polished, before using, all the better, as the smoother the surface the less labor required to remove the coating. I have generally found the best method to do this was to let it have a few minutes of high steam upon it, while empty, which will produce a brittle crust of the

scale and induce it to scale off; then, by using a broad chisel with a long handle, in the manner of a shovel, the work will soon be accomplished. To remove the coating from the kettles of Louisiana, they heat them red hot, and thus carbonize the vegetable properties. and cause the accumulation to scale off. I would caution those using plate pans against that process, as it will warp the wrought iron, and soon crack those made of cast iron, unless all parts can be heated at the same time equally. The exhaust steam of an engine, although possessing considerable caloric, is, nevertheless, not sufficient for defecating. It will not raise a temperature above 175° or 180°.

The use of sulphuric acid in diluted form was recommended at our late conveution, to be employed by an old stump of a broom.

It has been suggested that, where a fire-pan is being used, there could be an extension of it back, over the flue, some twenty feet, with a false bottom or steam-jacket, with the extended fire passing below, and the exhaust steam being above, between the fire and the juice, it would become somewhat superheated thereby, and thus the juice defecated, or, at least, very well heated, before entering the evaporator. This may appear plausible, but I have very little confidence in producing any marked effect with steam, except under a pressure of some fifty pounds or more. Should this plan succeed, even so far as to condense the exhaust steam and simply heat the juice to 175°, it will be a saving equal to about twenty per cent. of the fuel required to evaporate the juice.

It is quite common in the southern sugar-works, both of the United States and of the West Indies, to use defecating pans separate from the kettle-range; these

are very often of heavy copper, two in number, and set upon the same flue, in the rear of the kettles, and sufficiently elevated to allow their being drawn off directly into them, leaving the scum behind, which is removed subsequently. These pans are set side by side, with dampers for changing the fire, at the pleasure of the operator. I perceive that most writers upon the subject of processes of the southern works, recommend allowing the heated juice to stand some fifteen or twenty minutes after the scum has become coagulated and raised to the top, before removing it. This may do in such cases as the above, but not where pipes are used, or upon pans difficult to clean, as the moment the heat is withdrawn, the scum not only ceases to rise, but commences to settle, and will soon attach to the pipes, or bottom, if a fire-pan. I am much in favor of the settling plan, but would provide for that a separate tank, as I shall describe in the next chapter.

The re-agents employed for defecating the juice are usually alkaline or albuminous; the latter, however, is too expensive for general use, but often resorted to for producing samples. There is, in this cane juice, a greater per cent. of acid than is generally supposed. I have made the following test, that will give some idea of the quantity. To forty parts of soft water I added one part of strong vinegar, and applied the test paper, and found the color indicated the presence of rather less acid than the generality of cane juice. This acid of the cane appears to hold in solution, or suspense, the green feculencies, for as soon as lime is added, coagulation and settling commences, which, in the space of one hour, will carry down nearly one-half of the scum. Now, if it is the fine, insoluble particles of lime, rendered neufral by the action of the acid, adher-

ing to the feculencies of the juice, thereby increasing their weight, and thus sinking them together, it would be fair to presume that the free use of any similar neutral ingredient, such as plaster of Paris, whiting, or even common clay, may serve as an agent for assisting a cold defecation of the juice, without prejudice to its saccharine properties. Any process that shall result in a successful defecation of the juice, *cold*, will be found a most desirable acquisition.

The use of lime is strongly opposed by some, either through ignorance or interested motives. I consider it as essential to the production of a good-flavored syrup as the use of yeast is to obtain light bread, and as essential for preserving it in a commercial condition as the use of salt upon bacon. It will be found, by reading all the authors upon the subject, that in the manufacture of sugar and syrup from the tropical cane, in all parts of the globe, lime is used. I here introduce a few quotations upon this subject, in order that those engaged in this business may consider well the methods so well tried and settled, as essential in the manufacture of sugar. Upon page 93 of a work called *Sorgho and Imphee*, by H. S. Olcott, the following occurs:

"So far, neither of the defecators have come into play, enough juice has been collected in the receiver to fill one of them. The cock of the receiver is opened, and while it is running in, the sugar master takes a little of the juice in a glass, and tests it with litmus paper, which, from a deep blue, changes in an instant to a deep red, when dipped into the juice, should an excess of *acid* be present. The juice is always acid, more or less, therefore, the question is not whether he will add lime or not, but *how much*. Having before prepared lime water, or mixed some cream lime on the spot, the

damper being raised, and the fire playing on the bottom of the defecator, he stirs in small portions of the lime water or cream of lime, till the litmus paper, which at first became a bright red on being immersed, now shows only a faint rose color. Here he stops, the juice is nearly neutral, neither too acid nor too alkaline, requiring but heat to make a good defecator, or separation of its albuminous and other feculencies, which, as the heat increases, rise to the top in the form of a thick, dirty crust, leaving the clear juice underneath. The moment the first signs of ebullition are perceived, the damper is let down, and the juice allowed to rest for fifteen or twenty minutes, when it may be drawn off underneath, clear and bright, leaving the dirty scum to be cleaned out when the defecator is washed for the next charge. After the train has been started, one of the defecators is always full, while the other is being cleaned out, and so on during the crop."

Upon page 161, vol. xv, *American Cyclopedia*, will be found the following: the writer having discussed various processes of milling cane, then adds:

"The crude liquor contains various impurities, as particles of woody fiber, coloring matter, different soluable salts, albumine, casine, wax, etc. The nitrogenous induces immediate fermentation and the conversion of a portion of the syrup into alcohol, and afterward acetic acid, thus not only reducing the product of sugar, but new compounds, which might prove detrimental, by acting upon the lead and copper of the apparatus, and adding their pernicious salts to the sugar. Not much time should, therefore, be allowed for a portion of the impurities to settle, before the liquor is drawn through the strainers of copper or iron

wire into the vessels for clarifying it. By the old method, practised in Asia, a series of eleven kettles, or earthen boilers, is set in a line, in a rudely constructed boiler-range, at one end of which is the fire, with a large iron boiler placed over it, and at the other, the chimney. The juice is first put in the boiler furthermost from the fire, and is gradually transferred to the others, as the process goes on, until the final concentration is effected in the iron boiler. The product is afterward drained, and the sugar is clarified by boiling again with water, an alkaline lye, and milk. A somewhat similar arrangement of kettles, to the number of four, five, or six, has been employed in this country and the West Indies; each kettle, however, having its own fire, and the defectation or partial purifying being effected, during the boiling, by 'tempering' the liquor with slaked lime. This, when used in small quantity, causes the glutinous matters present to coagulate and rise to the surface in a scum, which may be continually removed by skimming. It also neutralizes any acid that may have formed. In Louisiana it has been the practice to concentrate the syrup to 42°, Baume, in the last kettle, called the 'battery,' and then transfer it to large wooden vats, called 'coolers,' for granulation; but the operation has been variously modified there, and different methods, too, have been pursued in the West Indies. Instead of kettles, each one requiring a separate fire, large, copper caldrons, or 'teaches,' into which the juice is conducted from the strainers in troughs, lined; and these caldrons are heated by steam, either by being inclosed in a steam-jacket, or by containing a coil of steam-pipe.

The clarification is effected, as before, by means of lime added to the juice, in the form of the milk of

lime, of known strength, and carefully graduated so that exact quantities may be used. Just enough should be used to neutralize exactly the syrup, which may be known, when litmus paper indicates neither an acid nor an alkaline re-action. An excess of lime should be particularly guarded against, as it involves a loss of sugar, and when it occurs, it should be corrected by careful addition of alum, or, better, of sulphate of alumina, which contains no potash.* The heat employed should not reach the boiling point of the syrup. At a less degree the scum gathers upon the surface, and when this rises in large bubbles, and breaks into white froth, the clarification is completed. The heat is then stopped and the liquor allowed to repose for an hour, when it is drawn away from the scum, and is seen, as it flows into the first of the evaporating pans, to be of a clear, bright, wine, yellow color. These pans, to the number of three or more, are set, in succession, over a flue heated by fire at one end. The liquor is gradually transferred to the smaller pans, and, as it boils away, the scum that rises is taken off. It is the skimmings in these operations that furnish the best materials for distillation, and the manufacture of rum is generally carried on in connection with that of sugar."

Upon page 792, vol. xx, *Encyclopedia Britanica*, will be found the following treatise upon this subject;

"The juice of the cane is a solution of sugar in water, with traces of albumen, of gum, and of a peculiar substance resembling gluten, a vegetable gelatin, also a minute portion of cerosin, and a green, vegetable wax. The mineral ingredients resemble those of

* I would recommend, instead of using alum, etc., to counteract an excess of lime, to add more juice, by which the same object would be obtained in a more satisfactory manner.—AUTHOR.

other plants and vegetable juices. * * * * The juice has generally a yellowish color, but is sometimes colorless, and grayish globules, suspended in it. render it turbid. It has an agreeable, but rather insipid, taste, and a peculiar, balsamic oder. It contains from seventeen to twenty per cent. of crystalline cane sugar, but the planter seldom obtains over seven-and-a-half per cent. There is a loss of sugar in the mode employed in expressing the juice from the cane, and, secondly, a loss arising from the change due to exposure to the air, whereby the crystalline sugar becomes degenerated into mucilaginous or non-crystalline sugar, commonly called molasses. Indeed, did space permit, it would be easy to show that the loss to the planter commences in an imperfect system of agriculture, the ground being worked by hand-hoeing instead of deep ploughing, and from a frequent absence of agricultural and manufacturing machinery of improved construction. The exposure of the juice to the air of a tropical climate, even for half an hour, would cause fermentation to set in; lime is, therefore, immediataly added, for the purpose of neutralizing the acid and rendering some of the soluable impurities insoluable. The old method of clarification of the juice is by heating it in iron pans, or 'teaches,' arranged together in a row, and heated by one common fire. The juice resesvoir, below the crushing mill, supplies the largesst pan—the fifth in the row, and farthest from the fire—with juice. The milk of lime, or *temper*, as it is called, is equal to about 1-800 weight of the juice, but the proportion varies with the quality of the juice; and the effect of the heat, which should not exceed 140°, is to coagulate the albuminous portions of the juice which rises to the surface in the form of scum. This is removed

by skimming, and the juice is passed through the other four 'teaches,' and evaporated at increasing temperatures, until the sugar will crystallize out on cooling. Scum collects on the surface of each 'teach,' and a great deal of it is nearly pure sugar, decomposed by the heat; it is passed into the molasses cistern, and is used for making rum."

It will be perceived that, in all the foregoing quotations, the processes there employed, embracing, as they do, those of the West Indies as well as of Louisiana, that in all of them the use of lime, for neutralizing the acid, is, in all cases, resorted to. I could increase the number, if it were necessary, as in all cases to be found upon record, both in the manufacture of raw syrup or sugar, or in the refining process, lime is used. Mr. Belcher, in refining the Sorghum syrup, producing the most delicious article, says he uses lime to correct the acid. See his letter, in the chapter on refining, etc.

Believing the foregoing evidence to be ample, without my own testimony, to establish the importance of using a neutralizing re-agent, the best mode of using it, as well as the ingredient to be used, become the legitimate subjects of discussion. The quotations indicate lime as more directly the desirable re-agent to be employed. It is cheap, and always convenient to be obtained. I have used several different kinds, but, unable to discover any very marked difference in the results, I would recommend the best white lime, possessing full strength; that, when slaked, and water added, forming a thick cream, would mark from 15° to 20° by the saccharometer. The stronger it is, of course the less will have to be added to accomplish the object, and, as a neutral in-

soluble salt is formed by its combination with the acid, it is well to avoid adding any already neutralized by exposure to the air. With a view to secure as complete a cold defecation as possible, I would recommend careful attention, to that end, and, as before suggested, the use of clean, light-colored clay, that may be found upon most any farm, a few inches below the surface. This I would suggest, as an experiment that can be tried cheaply, by dissolving the clay, and mixing enough through a few gallons of juice to give it a slight change of color, then add the lime immediately, and stir all well together, and allow the batch time to settle, which may take an hour or more. Then, by the use of a draw-off gate, which should be so arranged that it will draw from the top first, taking what has become clear, and thus afford more time for the residue to settle. Mr. Schwarz thinks the use of clay unfavorable in sugar-making and also to the preservation of syrup through the hot weather, (see his essay.)

These suggestions were made sixteen years since and are repeated only as suggestions for experimenters, later tests are probably more useful.

Plaster of Paris, or common whitening, may serve this purpose of defecation better than clay; neither of these possess any perceptible alkaline properties, hence their use will not supersede the use of lime, or only in a slight degree. The principle upon which I conceive their action to be based, is a mechanical one. I have found, in using lime in cold juice, that a subsiding of the green feculence would immediately commence; whether the result of mere neutralization, or from the mechanical action of the insoluble particles resulting therefrom, attaching to the fecu-

THE COLOR OF FRESH MADE LITMUS PAPER.

COLOR PRODUCED WHEN DIPPED INTO ACID JUICE.

COLOR TO BE OBTAINED BY NEUTRALIZING FOR SYRUP ONLY. FOR SUGAR THERE SHOULD BE NO CHANGE OF COLOR FROM THE BLUE.

lencies, and thus increasing their weight, causes them to sink, is difficult to determine; but if the latter conclusion is correct, then it is quite probable that the foregoing suggestions, in regard to the use of clay, plaster, etc., may be essential.

I have found, by a small experiment, in using lime to some little excess, and then adding a solution of alum, that a more complete coagulation and settling is effected; besides, the lime having produced a darker shade in the juice, the alum serves to restore the former hue, as the effect of acid is to bleach.

I am unwilling to recommend the use of filters for raw juice; they are too liable to get sour, and if of any material fine enough in texture to accomplish the desired object, they would fill up every hour, and require more washing and labor to keep them in a condition to be useful, than the benefits realized could confer.

In order to illustrate more clearly the action and reaction of the acid and akaline properties upon test-paper, I have introduced, upon the opposite page, the colors representing the tints that should follow the use of litmus paper, as there explained, so that there need be no mistake in the treatment of the juice. An excess of lime is detrimental, and should be avoided, which may be very easily done by attention to the use of the test-paper. As the juice is more or less acid, lime should be added until the colors of the paper are obtained, as seen and explained on the page referred to.

An excess of lime may be detected by re-using the red slip, by which it will be restored to the original blue or litmus color. In order to counteract any excess of alkali, the addition of a few gallons of fresh juice

will be found better than other acids, such as alum, alumina, etc., as is sometimes recommended. Mr. Lovering, of Philadelphia, one of the most successful sugar refiners in this country, not only neutralized fully with the milk of lime before boiling, but having reduced it to a suitable degree, and filtered it, he added clear lime-water again in his final boiling, which, he says, enabled him to take off a thick, glutinous scum. (See his report, in the chapter on Sugar Making.) This agrees with many experiments of my own, where I have sometimes found it difficult to obtain a satisfactory rise of scum in my second boiling; by the addition of a little more lime, good results would follow. But there is another necessity sometimes for adding lime. A careful operator, whose taste has become expert, by practice, can detect the noxious, grassy flavor at this stage of the process, say 20° or 25° B., which, by the addition of a little lime-water, will be removed. I have found it objectionable to have a hand, at this department of the process, who chews tobacco, as he is most sure to neglect this test, preferring to neglect the test to losing a quid; besides, I doubt whether such persons have as scrutinizing faculties, in this respect, as those free from such a miserable practice.

It is the grassy flavor referred to that is so objectionable in the city markets, and this flavor is more or less distinct, as the acid is more or less abundant; hence the destruction of the one is the removal of the other. I am aware that the deposits upon both the defecators and evaporators will be considerably increased by this mode of treating the juice, but let it be so; have our works so constructed that they are competent to endure it, and most convenient for the purpose. The acid has some little action, chemically, upon the metals, which

serves, to that extent, to keep them clean, but, at the same time, the effect upon the syrup is, to the same extent, prejudicial; this, however, is quite limited in either case.

Before closing this chapter, I will suggest to those having syrup on hand possessed of this acid and rankness, to take a gallon or two, according to size of the boiler on hand, and add to it one-fourth water, and, as soon as warm, add lime, according to preceding instruction, stirring it thoroughly through, and as soon as heated to near a boil, remove the scum, and boil it to about 35° B., 228 F, and the change will, no doubt, be satisfactory. In this manner I have restored old-crop syrup, that had become so tart that a complete jelly had formed, and the odor arising from it when boiling was at first quite offensive, but finally changed and became, at the close of the few minutes' boiling, as rich aud aromatic as a new crop boiling. The addition of well-beaten eggs, in milk or water, say one to every two or three gallons, and well stirred in before the syrup is hot enough to cook them, will be found quite serviceable. Fresh bullock's blood, (this is now being furnished in the form of a dry, brittle article called prepared blood or albumen,) about one pint to ten gallons, will serve well as a substitute for eggs. In the use of these albuminous agents, it will be well to have the heat applied very gradually, and considerable time allowed for the scum to rise before ebullition commences.

In the usual method of using blood for clarifying, the fire or steam is withdrawn, and the batch allowed to rest for half an hour or more, and then the defecated juice drawn from under the blanket of scum. But in the use of those pans or evaporators that operate by a

continous flow, the same plan can not be pursued. It would, however, be better that the tempered juice or syrup should be admitted at the cooler end of such evaporator or pan.

I here quote from an article, upon this subject, that I furnished to the Agricultural Department, at Washington, in 1861; although there may be some repetition of my views already advanced, still there are others contained in it equally useful, and not embraced in this chapter.

Upon these subjects much has been said and written, and many are the pretended discoveries, especially in regard to defecating, which have been published. I find, however, that the well-directed application of heat is the greatest of all defecators, or, as some call it, clarifiers. The natural acid of the cane, which is more abundant than is generally supposed, acts as a serious obstacle to defecation; and, according to my experience, it is very impolitic to inspissate the juice without a very near approach to neutralization. Lime —the ordinary quick-lime—I have found to be the best re-agent for this purpose. Soda, in the cheapest form, is much more expensive than lime, and, being a carbonate, has the fault of producing effervesence; moreover, when used to excess, it leaves a flat, alkaline taste, which is not the case with lime; lastly, in no respect does it serve a better purpose than lime.

Bi-sulphite of lime has been used to considerable extent in Louisiana, and although it favors crystallization, yet it produces a softer grain of sugar, and is, in some other respects, inferior to the simple lime process. It has also been used experimentally in the Sorghum works, but I am unwilling to recommend its use from any evidence yet adduced. Very many persons un-

acquainted with the chemical changes that take place when lime and acid are commingled, seriously object to its use, they supposing that the lime actually remains to be digested in their stomachs, while the fact is, that a perfect neutralization takes place, and nothing but a neutral sediment remains, which generally attaches to the pan, or pipes, or settles in the "prop," if allowed to do so.

It is a great pity, and rather detrimental to the immediate success of this crop, that several parties engaged in the manufacture of apparatus have, doubtless in good faith, strenuously urged the disuse of all alkaline or other defecating re-agents. The result of such a direct inspissation, it is true, is a syrup of somewhat lighter color; but it is less sweet, in the direct ratio of the free acid contained in the cane; and, moreover, the syrup so made contains within itself a ferment, which, unless the syrup has been concentrated to an undue thickness, will make it work, and become tart in summer. This fact has led many to suppose that the Sorghum syrup could not be made to keep good in warm weather, and that the rank, herbaceous flavor could not be removed.

During the past season I have re-handled several barrels of such syrups On adding about eight gallons of water* to each barrel, and about six quarts of lime-water, 14° Baume, and applying a boiling heat, there rose to the surface a thick, green scum, and in the steam a very offensive odor escaped. From each

* This addition of water is in order to permit of reboiling, and for no other purpose. Here I would mention that by merely reducing syrup with water, and reboiling to the same consistency, a darker syrup will result; and so in working cane, wet with rain water, a darker syrup will result.

barrel I usually found about four gallons of this scum to separate; and the syrup changed by this treatment from a fair straw-color, with a greenish tint, to a deeper color, rather amber in tint, when seen in thin strata; at the same time, from being turbid it changed to something approaching brightness.

Albuminous substances, such as eggs, blood, etc., have been used from time immemorial for coagulating and removing scums; the first of these is too expensive except for laboratory use, on a small scale, and the latter is not always to be obtained. On experimenting with bullock's blood, I found it to determine the separation of a large quantity of scum, without, however, rendering the syrup perfectly bright and clear. After filtering, however, through animal charcoal, the remaining cloudiness is entirely removed, and the syrup is left bright, of an amber color, and having a most pleasing flavor—of a quality to insure its being found, when produced in full quantity for the markets, on the tables of our best hotels and families.

It is difficult to indicate with exactness the quantity of lime requisite to neutralize the acid of the juice, as for different samples, grown in different seasons or localities, a different quantity is required. The litmus paper,* in the hands of beginners, and

* To make litmus paper, procure half an ounce of *litmus*, which all druggists keep for sale in cities, and will send by mail for a few cents; infuse this in hot water for about ten minutes, and then, in the clear, blue liquid decanted from the dregs, immerse unglazed, white paper, and hang it up to dry. It should be of a full, pure *blue* color; cut in strips of convenient size, say half an inch by three or four inches, and it is fit for use. Preserve it from light and air, or it will change color and become violet. To use, dip one end of a strip in the liquid to be tested.

probably in those of old operators, will be the best guide, and, like the saccharometer and thermometer, should never be absent from the works. My practice is, to add the lime-water by installments in the "grand" boiler, until, upon testing with the litmus, the juice changes the *blue* color to a *purple*. Before adding the lime, the acid changes the paper to a bright pink color. Practice will soon indicate the proper colors to be sought for, and in testing it will be well to dilute the inspissated juice with water, as its own color is apt to be mistaken, by beginners, for the effect of an acid reaction. In making lime-water for neutralizing, it will be found that, as the water only dissolves a very small quantity of the lime, the remainder settling to the bottom of the vessel, it is better to agitate before using, whereby a larger quantity of lime, being held in *suspension* by the water, will be introduced into the syrup or juice.

I find the following appropriate remarks, upon this subject, in Porter's work on Sugar-cane:

"The juice being composed of solid and fluid parts, united with a very great proportion of water, the first object proposed should be to separate and remove the solid parts. The operations which tend to deprive the juice of all solid matter, both feculent and earthy, is called clarifying. These substances removed, there remain the water, the mucous juice, and the mucilage, which form together the cane liquor. The next step is to expel, by means of heat, the water which is over and above the water of solution; this is evaporation; and the juice is then designated syrup. The feculencies and the superabuudant water removed, the water which remains just holds the soluble matter in solution; this is called

the water of solution. The object of the work in the last boiler is to remove, by evaporation, a certain proportion of this water; the action of heat upon the water of the syrup is called concentration. It is clearly seen from this, that the manufacture of the expressed juice consists of three principal operations, successive but very distinct, viz.: clarifying the expressed juice into cane liquor, evaporating the cane liquor into syrup, and concentrating the syrup into the state for crystallization.

"The clarification is the first and most important work required. Its aim is entirely to disunite and remove the feculencies, and to separate the earthy matters which accidentally fall into the juice. The means employed to decompose the expressed juice and to disunite its feculencies are heat and alkalies; those which should be used to remove them, are skimming, filtration, and time for subsidence.

"Heat, in the first moderate ebullition, acts particularly upon the first kind of feculencies, which it separates easily, and raises to the surface of the fluid, whence they are removed by a skimmer. The second sort require a strong ebullition to separate them. It often happens, especially when the expressed juice is of very good quality, that heat alone suffices to effect the complete separation of the second kind of feculencies, and although the flakes formed may not always be sufficiently large to be raised by a skimmer, it is enough if they are disunited, because then they will not escape filtration and subsidence.*

Alkalies, are, in this case, happily dispensed with;

* "In some parts of Jamaica, where the cane liquor was exceedingly rich, Mr. Bousie made very good sugar without a particle of temper.—*Edward's West Indies.*

an advantage which can never be enjoyed in the usual method in which they must be employed, not only to separate the feculencies from the juice, but also to unite them together under the form of a frothy scum, which the skimmer may be able to collect and remove with facility. When the feculencies resist heat, it is proper to employ the concomitant action of alkalies. Lime ought always, in all circumstances, to be preferred, because, in separating the feculencies, it takes from them but a comparitively small portion of their mucilage, and when its action does not produce the required effect, which, however, is an extreme case, it should be seconded by that of potass or soda. As the lime, in this method, has only to assist the action of heat in separating the feculencies, it need not be used in so great a proportion as in the usual method, where it is also required to give them a frothy consistence to collect them on the skimmer. Whatever care, whatever attention is given in removing the feculencies, as they gradually rise on the surface, it is impossible to get rid of them entirely by the skimmer alone; this is not only insufficient for the feculencies, but it can do nothing for the earthy matters which are accidentally mixed with the juice.

"Dutrone was convinced of the absolute impossibility of entirely removing, by the skimmer, the impurities belonging to the juice, and the extraneous earthy matters which are always, in a greater or less proportion, found in it. He, therefore, saw that it was absolutely indispensable to filter and to leave the liquor to deposit before concentrating. For this purpose he adapted two reservoirs to communicate with concentrating vessels, which fulfilled this end admirably well, and produced the greatest advantages."

In the foregoing, it will be perceived, that reliance is placed in sudsidence or settling, as also the use of lime, although there were instances where little lime or temper was required. Syrup from sandstone or soft-water soils will be nearly as acid as though made of the juice of sweet apples.

CHAPTER VIII.

STEAM DEFECATORS AND FIRE EVAPORATORS.

Including Mr. C. M. Schwarz's Essay before the Convention.

In the arrangement of such as the above, the construction of a defecator on the same plan as that shown in the cut of the chapter on steam works, will be found well adapted. The frame (so to call it) of the pan may be of good well-seasoned pine plank one and a half or two inches thick, thoroughly put together with tongue and groove joints, painted on putting together, and the inside and outside painted with two coats of red lead and boiled oil paint. I will add just here that it will pay to have all tanks, coolers and troughs about a sugar-works so painted, because it will protect them from absorbing saccharine and afterwards souring, besides being easier cleaned and less liable to shrink and swell, besides adding to the cleanliness of appearance to the place. This advice I had many years since by my much esteemed friend the late Wm. H. Belcher, and in employing it I have had occasion to thank him many times. There need be no fear of the paint boiling off, as the more you heat it the firmer it seems to adhere.

The capacity of defecators will depend upon the extent of the works, but as a proportion let the length be about four times the width, with a slope at one end of about six inches to the foot. Now, having the coil transverse, and steam entering at the head of the defecator, which will therefore be most heated, and the condense discharged at the foot of the slope having lost its greatest heat, it will be perceived that should boiling occur the scum blanket will be forced to the slope where it can be drawn up by a scraper and dropped into an inclined trough, and thence to a suitable tank arranged for it.

It will be found economical to have hinged lids to the pans, as shown in the cut, for same reasons there assigned. In the use of this kind of defecator the operator has the entire control of the heat, and can strike off a second blanket very nicely. I found after the first was removed, that by the addition of a bucketfull of cold water, with only a little additional lime, say about 2° B., that a second blanket would rise nearly equal to the first, but it is best to have just enough steam on the coil to prevent a precipitation of the feculence as it will adhere to the pipes and sooner coat them. For a coil in a defecator, if the return binds were such as to place the cross pipes about four inches apart, I would think it preferable to those of closer construction, not only for the convenience of cleaning, but it is not desirable to raise the heat in the juice too rapidly, and for this reason a lower pressure of steam is quite as good, say forty or fifty pounds, while it will require seventy-five to eighty-five to do the most profitable evaporating in open pan. In order to discharge this batch quick there should be a large outlet, at least five inches diameter, and the pan arranged for settling to facilitate

the discharge, as in the use of steam all such manipu lations must be made with dispatch. Brass or copper tubing are preferable for the two reasons; first, conveying heat more freely, and second, having a smooth polished surface are more easily kept clean. The first cost will be much more but they are more durable and efficient while in use. This defecator will be found very serviceable in reboiling and grading syrups that have fermented and become unsuited for use or market. Upon this subject I shall treat more fully in another chapter, under the head of syrup-making, &c.

ESSAY OF MR. SCHWARZ.

I will not take up much time, as there are many here whose experience will be valuable for myself as well others. I shall give my own experience and a description of machinery and buildings I erected for my own use. In the first place, I would advise against setting cane mills on posts; the arrangement is a very expensive one in the long run, as there is no way to haul cane to it on a track with trucks. Carrying cane on the shoulders is best appreciated by those who have tried it, and there is no way to use a bagasse carrier which would save one hand. Carrying the juice in buckets from the mill is wasteful. A pipe laid under the horse track is hard to keep sweet and clean—besides, you can never tell where it leaks.

I use a vertical three-roll Victor mill, with sweep below. My building being upon a side hill, my cane yard was nearly on a level with my mill, by which I ran my cane to the same on a truck. This enabled me to feed the mill with two hands, while by means of an endless apron driven by the mill, the bagasse was discharged out of the building.

For the convenience of feeding with cane apron, and discharging bagasse also by apron, thereby saving one hand and doing the work still better, I would recommend the use of a strong horizontal four-horse mill, with sweep below; two horses will do even bet ter work. If crowded with work, another pair may be put on without danger of breaking down. This plan is much better than getting a one-horse mill, then putting on two, break down, and then complain that the mill is too weak.

The advantages of this arrangement are many and important. When grinding directly from the field, the cane is unloaded direct on the floor, which will hold, if necessary, from ten to twelve loads of cane, thus providing for a rainy day. A wooden track, made in sections and laid from the floor out to the cane yard, and a truck or two for hauling up cane, and a bagasse carrier at the back, will save much work. As Mr. Hedges has suggested some improvements on the latter, I will leave it for him to describe.

For conducting the juice from the mill, I use a covered V-shaped trough, long enough to pass from the mill to the boiling room into a tank holding 200 gallons of juice, called the custom tank. The juice is measured in this when grinding for customers that have small lots, where it may take three or four of them to make a day's work. A guage rod, marked for every eight gallons of juice up to twenty-five, shows at a glance how many gallons of juice or syrup there are when one lot is done. This is on the supposition that eight gallons of juice make one gallon of syrup. which is not always the case; but after the syrup is divided by eight, the overplus, if any, is divided in proportion to the number each have received, and it

works well. Care is taken to always work up the same kind and condition of cane together. Scales to weigh the cane would perhaps work more correctly, but are too expensive for a small establishment. I have described this proceeding at length, because there are some who imagine that we just guess at it.

From the custom tank, after being measured and recorded, the juice is let into the feed tank of the same capacity, which supplies the heater. This has an iron swing pipe that draws the juice from the top, leaving the muddy sediment at the bottom. I have said nothing, so far, about straining or filtering the cold juice. I don't do any of it. One extreme follows another. I have tried the cold juice straining, and found it a failure every way, even with straw or hay. Any coarse particles that would be caught by such straining is the first to be floated off in the scum. The less juice is exposed to the air, the better.

From all the tests I have made, I have come to the conclusion that the more the juice is kept in a body together, the better. When the custom tank is ready to be let off, the floating impurities are skimmed off the top, and the swing pipe in the feed tank leaves the muddy sediment in the bottom, and that is necessary when using a heater.

The use of clay has been revived of late. I say revived, because Mr. Hedges suggested its use in 1863. I will only say in relation to it, that when lime is used afterwards, or sugar is the object, it is useless. It makes a light-colored syrup, but, unless boiled down very thick, it will not keep well, and it will have a strong tendency to jelly the following summer.

Now, the heater or defecator comes next in order.

It should be large enough to hold a hundred gallons —more or less, according to the extent of the works. Sixteen feet by thirty inches is a goodsize. I use coal for fuel under this altogether. I run in 100 gallons or so and while this is getting hot, let us talk a moment on what we are trying to do, for this is the most important and particular part of the process.

There are two great obstacles in the way of granulation—the vegetable albumen and glucose. The first we must get out and get rid of as much as possible, for the flavor of the syrup depends on doing so; the other we must prevent from getting in—not but what there is glucose in already to some extent, but this does not trouble us much; but the conversion of sugar into glucose is the greatest drawback to the making of cane sugar.

The vegetable albumen, I think, exists in the juice in two forms. A portion (about half) is in a free state, and will coagulate when heat is applied; the other portion is held in solution by the free acid, and will not coagulate, unless it is neutralized. So I use no lime in the cold juice. When the heat has gone up to between 165 to 180 degrees Fah.—Mr. Stewart thinks 180 the right point—I put in the lime; but, as to the quantity, I am regulated by the condition of the cane. If the cane is freshly cut from the field, and we intend to make sugar, we put in enough lime to completely neutralize the acid. The quantity depends on the strength. It varies from five to seven pints of the milk of lime to one hundred of juice, but the litmus paper will show how much to use.

Now, this would spoil it, if were not for what is to follow—that is, to re-act the lime again and stop its action on the sugar. Lime may be considered a nec-

essary evil, and after it has completed its mission, we must get rid of it as soon as possible. It should be well stirred in when added, while the fire is kept up. When the first blanket of scum has been formed, and it shows indications of boiling, the fire must be checked, the scum removed and the juice run into the settling tank, and the clear juice drawn off the top as soon as settled. This must all be accomplished by the time it has cooled down to 150 degrees Fah., and then the sulphurous solution is added—enough to bring the juice back to the desired acid state. This stops the action of the lime, prevents the discolor, and checks the conversion of sugar into glucose.

It has been my aim for some time to find some agent by which lime could be used to the fullest extent. I have tried all the acids that were safe in this connection. Sulphuric and muriatic acid in small quantities do well for syrup, but in using enough necessary to counteract the lime, they will convert all the crystallizable sugar into glucose while boiling in half an hour; the decolorizing action of the sulphurous oxydes and its action in preventing decomposition, are well known.

It seems now that Mr. Stewart and myself have been for years experimenting in the same direction and arrived at the same result. He has perfected a solution of dioxyd of sulphur, which may be all that is desired.

Our next step is to boil down the clarified juice in a shallow bed as rapidly as possible to about 225 degrees Fah. Now just here arises the use of an agent which, as yet, we have not been able to find, and that is a suitable finishing pan. It should be made to dump the contents at once into the cooler when finished.

Mr. Hedges has been at work constructing one for me which I think will be just the thing. In this the syrup is boiled down to 235 degrees or thereabouts, stirring it slightly at the last stage, and then tilling it out into the cooler; when cooled, it can be run into granulating boxes, tanks or open barrels, and kept in a warm place for granulation.

I will here state that there is no use in trying to dry this sugar by natural draining, pressing or leaching. A centrifugal is a necessity here. By its use the sugar will have a lighter color, better grain and a portion of glucose, which, if leached out the old way, will be saved. The centrifugal will be useful to pass the syrup through to free it of all and every little mote, fly or foreign particle in it.

Now, having come to the end of the sugar process, we must go back and see what is best to be done with cane not in a condition for sugar by bad cultivation or exposure. This cane will only make syrup, and sometimes the best, if not too much damaged.

We heat the juice as before and put in the lime, as we have done for sugar, but not quite so much—enough to separate well without darkening the juice too much. When the litmus paper turns to purple color, as shown in Mr. Hedges' book of 1863, it is limed about right, if the cane is not damaged; but if it has commenced to sour at the ends, the litmus is not a reliable test—for the acid of fermentation cannot be neutralized with lime to any extent, as an excess of lime forms, in connection with the inverted sugar, into glucose, and the starch into a kind of paste, and in the boiling produces a jelly-like mass (gelatinous starch or amidine) which, in combination with other

salts, forms a hard crust on the evaporator different from the lime scale alone. The best test is to put a little limed juice in a glass tube, and if it settles by forming long streaks through it, without too much darkening of the juice, it is all right; but if it looks cloudy without separating, more lime is needed. This is the most particular part in the whole process. I have had men to fail in it, and a boy sixteen years old to succeed. If too much lime has been used, some acid may be added, as in the sugar process already described.

Those using the Clough refining process have an advantage in settling the juice more quickly by combining the No. 1 with the lime. In speaking of that process I will state that I have made about 20,000 gallons of syrup with it, with some changes in the lime; using it neither in the cold nor boiling juice, for reasons above stated. When ready to boil, remove the scum, boil rapidly a little while and run into the settling tank or settle into the heater, as performed by some; but in doing this it requires two heaters thus saving a settling tank. I have found no advantages in it, as for destroying coagulation by drawing into settling tank I have found the cause mostly in the lime, especially when used in a dry state. I have, for a number of years, used it that way myself, but now prefer the milk of lime.

The balance of the operation needs no particular description, only the boiling should be rapid in a shallow body, but if we want to make an even grade of syrup it is much better to use a finishing pan, for the reason that then the evaporator can be worked by a less experienced hand, and the syrup finished to any low degree we choose without danger of scorching.

I will now give what I consider some of the principal reasons why sugar has not been made to any extent from these canes. In doing so, I shall probably disagree with some of the established theories of sientific men in relation to sorghum, but I cannot help that, for the results, when based on these theories, have been satisfactory to myself, and that is what I care most about; and, besides, chemists do not always agree.

There has been a great mistake made by men of science in supposing sorghum to be identical with southern cane, and hence it should be treated alike. This is one reason why science has done so little for sorghum. In fact, it drove about eight out of ten manufacturers back to the primitive process of heat alone, and what has been done by that these twenty years? It is a mistake, and hence the failure.

If we take good ripe cane, cut it and let it cure in small piles for three or four days it will look in its best condition and the juice look all right. There is no perceptible change; the syrup will run off all right, bright, of good color and flavor, and if boiled thick will granulate. Now take a centrifugal and drain it and then what have we got? Why, glucose. Now let us cut and haul to the mill, grind and boil right along, neutralize fully the free acid and also the lime in return, rush right along as fast as possible up to 225 degrees of Fahrenheit. It may take a rest here without injury, even to its advantage, if a strainer or small filter is used; then into finishing pan to 235 degrees. This will generally commence graining in six hours. Now, if we put this in a centrifugal, we find the syrup running off more readily, the contents of the centri

fugal changing to a light color and feeling more dry, and now what have we got? Cane sugar mostly.

NOTE.—Since the close of the convention Mr. Schwarz has continued his investigations, and discovered what had also become evident to me, that cane grown in high western and northern latitudes does not require the application of the same per cent. of reagents as that in the lower or eastern latitudes and climates.

This discovery is due to our treatment of Mr. Kenny's syrup sugar. Mr. S. says, less lime is necessary and dispensing altogether with acid, or solutions of any kind. I am being favored with some careful investigation by Mr. Belcher in this direction, for use in this work.

These conclusions are confirmatory of my oft-repeated opinions, viz., that by attention to selection of soils and right cultivation, in suitable climates will make this an easy and sure sugar-making crop. AUTHOR.

CHAPTER IX.

EVAPORATING APPARATUS, HOW USED.

One of the most important steps to be taken by any person engaging in this or any other business, is first, to arrange, in his own mind, some system by which to be guided, and to that end he should read, write, talk, and listen to others talk, always scanning their motives and interest, as well as their opportunities for information upon the subject, discriminating between that which is given as opinion and that of knowledge

I will here introduce the experience of a farmer near Osborn, Ohio, as related to me a few years since. Having some ten acres of good cane, he obtained a mill and evaporating apparatus, with instructions for working. This being his first experience, he was considerably confused during his apprenticeship, and after some few days' working, he was persuaded that his instructions were not correct; he thereupon changed and took advice of his neighbor, and conducted his boiling accordingly. After he had concluded his opera-

tions, and began to seek a market for his syrup, (having some fifty barrels,) he discovered a decided preference given to his first boiling, although made during his days of inexperience. This led him to reflect and apply his own scrutiny, and he found that all he had made after his change of process, was inferior. That change consisted simply in omitting the use of lime.

New beginners should experiment cautiously, and upon a small scale, until they have become familiar with all the qualities and indications of good syrup and sugar. The eye alone is not the umpire to whom the question of quality should be referred, although it has much interest, and should be, and is, always consulted; nevertheless there are properties that may be incorporated in the syrup very prejudicial to the taste, and yet entirely secreted to the view.

We now have on sale in most of our city and even country town groceries, a syrup that is made to suit the eye, at the expense of the palate. I refer to the N. Y. fancy styled "silver drip" and other like names. This consists mostly of glucose with about one-fourth to one-third cane syrup to give flavor and sweetness.

The constituents of glucose is shown in an able article of my friend Mr. Geo. C. W. Belcher, to whom I am under obligations for an introduction to this work on sugar, &c.

Now a small per cent., say 10 or 15, of glucose may be useful to prevent crystalization in some of our syrups that does not possess sufficient crystalizable sugar to justify boiling to that degree for sugar, but enough to granulate partially and render it unsable as syrup.

The construction of evaporating apparatus are as

various almost as men's ideas, but there are general principles that should be observed in the arrangement of furnaces and fixtures for boiling. In the first place, durability, by which money, once invested, may yield a return before the structure has failed to serve the purposes for which it was originally designed. The constant action of a brisk fire, for successive weeks, upon the one side of any thin metal, and at the same, time, also, a still more active wear, by oxydation and friction, in the manipulations of cleaning, upon the inner surface, must very soon render pans thus constructed, useless. But, like wooden mills, they may serve very well for a time, during the experimental operations of new beginners; but, as the business becomes settled, and the experience of the operator will justify, the arrangement of more thorough and permanent works will suggest itself as more profitable.

I would, by no means, advise any one to embark precipitously, without experience, into this business. The difficulty of obtaining the assistance of experienced hands is one of the principal drawbacks to a rapid extension of this enterprise. There is more depending on the *man* than the apparatus, in the production of a good article, but the economy of the business depends principally upon the arrangement and extent of the works, and constitutes the second point of consideration. As previously intimated, small works can not be made to afford profitable employment for the operatives, as, for instance, one hand was fully competent to attend my fire-pan, with which I could make forty gallons of syrup per hour, and, had it been double its capacity, the same hand could still have performed the labor; the only increase of labor being in handling

the increased amount of labor to keep up the fire, as this labor is also perfomed by the one same hand.

The matter of fuel constitutes an important feature in the economy of syrup and sugar making. In my works my fuel bill was fully forty per cent. of my running expenses, and still I used only about three-fourths of a cord of wood to the hundred gallons of syrup. A well-arranged works will turn out one hundred gallons to the cord, generating steam with the same for grinding. This, I am sure, is upon the safe side in the estimate. I have seen lower figures, but I am not willing to place it less. I can not give the exact data, as I obtained power for grinding from another boiler, and a portion of its steam was used for other purposes, but of one thing I am sure, that I lost largely from the lime coating upon my boiler by the use of hard water, and neglecting too long to clean out.

The use of long ranges, or evaporators, are the only sure way to economise fuel. To obtain rapid boiling will require a strong draft; this, of course, will give great velocity to the flame, and, unless the ranges, whether of one or more pans, are lengthened to twenty-five feet or more, there will, of necessity, be a large per cent. of caloric passed into the chimney. It is a well-settled principle, in the construction of steam boilers, that one of less length than twenty-five feet, with return flues, (of the same length, of course,) is not an economical use of fuel. The heigth of chimney should, at least, be equal to the length of the horizontal flue, and increased two feet for every one foot of descending flue. In size, the flues and chimney should contain fully two-thirds the number of square inches* that

*To obtain the square inches in a round cask or chimney of a given size, say twelve inches, multiply it by itself, which gives one

constitute the openings of the grate-bars; if they are equal they would do no harm. Persons erecting furnaces should, by all means, give attention to these points; I have known repeated instances, where the whole chimney and flues had to be taken down and rebuilt, on acconnt of being too much contracted. Evaporators and pans have been often condemned for not doing what they were recommended, when the fault was entirely in the construction of the furnace and flues.

It is very convenient and important to have hot water always at hand during boiling time, and, for this purpose, I would recommend one of two plans: first, provide in the flue, either behind, or to the right or left (as may be most convenient to set the chimney) room, and set a common kettle, of whatever size desired, in which there may be, at all times, hot water. Another plan would be to station, on end, at one side of the furnace, back of the fire, an open barrel, with a piece of gas-pipe screwed into it, near the bottom, and passing through the fire and out on the opposite side, with a faucet in the end; the barrel, filled with water, will soon become heated, and furnish a supply, which may be drawn from the faucet, for washing the various implements, as well as the hands of the operatives, none of which can be kept too clean, Hot water and dish-cloths, or a sponge, are as important in a sugar works as in a kitchen.

The other essentials commonly required may consist

hundred and forty-four; three-fourths of that is one hundred and eight, which will be about the square inches contained in the circle. If it is desired to get the capacity of a cask, multiply the product thus obtained, by the inches in depth, and divide that product by two hundred and thirty-one, (the number of inches in a gallon,) and the quotient will be the answer.

of the following: A thermometer saccharometer and test cup, a long-handled pint dipper, for the syrup, and one of a larger size, for the lime tub, a few sheets of litmus paper, a bucket or two, and a gallon measure and funnel. These will constitute an equipment for service. In working upon a small scale, say a two-horse mill that should return from one hundred and fifty to two hundred gallons per day, it will generally be found more convenient and safe to have two pans, a "grand" and "strike," or a defecator and an evaporator; operators of more experience will do nearly as well with one. This, however, does not admit of the settling or subsiding arrangement referred to in the preceding chapter, without involving the necessity of lifting the juice back into the boiler.

Mr. T. J. Orbison, of Troy, Ohio, used two fire-pans, with a settling-tank between, as represented in the cut on page 81. The "grand" being positioned sufficiently elevated to allow the "cero" to flow into the "prop," at one end, and the other pan, or "strike," sufficiently lower to allow the contents of the "prop" to be discharged into it from the other end, which may be done by batches or continuous flow, as best suits the operator. Mr. Andrew Clemmer, of Johnsville, Montgomery Co , O., reported, at the Dayton Convention, having made an excellent syrup in a plain, straight pan, by a continuous flow. He has had much experience in syrup making, with different apparatus, and hence is more expert in the business.

I have no doubt that in those districts of country contiguous to refining establishments, the syrup will find a market fully as profitable when inspissated only to 22° or 24° B., as it has to be reduced again, if heavier; and inasmuch as the high heat, necessary to a

full inspissation, is of great injury both to the flavor and color, and still more so when it is designed to make sugar, therefore, this method may be found ultimately most profitable. A description of the procedure and manipulations of such works as just discussed will familiarize the mind of the reader, and thereby more fully impress it upon the memory.

Supposing all things in readiness, the mill starts, the juice passes through a No. 24 seive, or small tub or box of clean straw as a substitute, merely to catch the small bits of cane that may float off in the juice and stop the pipes; it is then conveyed by pipe underground, and received in a tank near by, and enough elevated to be drawn into the boiler; as soon as sufficient is received, say ten or twelve inches deep, the stream should be turned into the other division of the tank (as there should be two) and the juice tempered by adding lime, as before described, until the test-paper shows nearly a neutral condition, (see page on this subject). During this time if water is convenient, some few inches of it in depth may have been put in the pan. and the fire started, so that the furnace may be hot when the juice is firsf let in, thus saving time. It will be found well to allow the juice time to settle after tempering, and when the arrangement for drawing, by swing pipe is used, the juice may have more time to settle, as the top is first to become clear. The first fill in the pan should not exceed one inch in depth, and then, by a little attention in the start, the scum may be completely removed, and then, by a continued steady supply and discharge, keeping up the same uniform depth and steady fire.

There is nothing in the process more detrimental than unsteady firing, there being a constant action and

re-action going on, by which the various changes are produced, causing the impurities to coagulate and rise to the surface, which are constantly differing in quality as the process advances, hence, if the fire slackens, the currents change, and instead of an aggregation of particles ascending and floating off by the current of steam generated, a segregation takes place, and the fine particles either become incorporated in the saccharine properties, or subside and attach to the pan, forming a non-conducting coating, that is difficult also to remove.

Sugar boilers are well aware how difficult it is to brighten up a batch that has once become, what is called by them, "greasy," the result of boiling in the scum once thrown up. This must be avoided. Well defecated juice will roll up a white foam, and if maintained steady, it is a sure harbinger of success.

The first cost of a mill is too often the bugbear that causes loss to the operator. It would be better to defer the business than to start with a little, cheap mill, that is only a source of annoyance, final failure and disgust.

In large mills, to be fed from an apron, rolls should be at least twenty inches in diameter, and of such length as to insure the capacity required. Two diameters in length is most common. My mill at St. John's, Ill., in 1864, was 20x36 inches; master-roll journals, six inches; lower rolls, same size, with five and a half-inch journals. These stood the test well, although we fed a cane layer six inches deep through between rolls forced together with a wrench four feet long, applied to four large screw-bolts.

Now I have to say that the results of Mr.

Kenny's working the past year, gives me increased confidence in our being able to produce a condition of cane whose juices will not need the use of re-agents at all. Whether this condition is due to the soil or climate is a question, the solution of which is of great importance.

I have found in our city a barrel of syrup made from this northern cane, in Montgomery county, Texas, latitude 31 1-2 degrees. The flavor is of the N. O. molasses precisely, which is a proof that the atmosphere out of which two of the three parts constituting sugar is taken gives the flavor to it; hence our far north and high tabled lands, where the pure air, abounding in oxygen and carbon, are to give us the finest flavored syrups and sugar. It is often remarked that there is a kind of maple sugar flavor. This cannot but come from the same source, the air. I shall expect to hear of good results from Pacific coast and the mountain districts, where by the selection of valleys that will feel the hot sun in the day and cool night air, the richest cane will be produced that will yield sugar of the most desirable flavor and in paying quantities, while the molasses drained from it will be an acceptable table syrup. I have proof of it in that which I have taken from the melado of Mr. Kenny's make, which is pronounced still equal to the best on exhibition, excepting Mr. Schwarz's, which had the benefit of lime and settling.

The use of the thermometer and saccharometer demand consideration here. The former is essential to determine the requisite degree to boil to for sugar and also syrup, and of a construction to suit the business. The latter is a small, glass instrument, for testing the specific gravity of all liquids heavier than water. By

these the juice may be examined, and also the syrup finished by them and, in the handsof a new beginner, are indispensable. By the table at the close of this chapter, and the use of these instruments, may be determined the sugar contained in each hundred pounds of juice. It will be perceived, by the explanatory note at the foot of the table, that every eight pounds of syrup contains three pounds of water. I have made a test of the table. and find it entirely reliable.

As I am constantly receiving letters of inquiry relative to the methods of operating steam works, I am reminded of the necessity of a careful, detailed description of my experience, with a view to meet this general inquiry. I shall have occasion again to refer to the plate at the commencement of chapter on steam sugar works,in order to assist the mind of the reader in more fully comprehending the discussion I have to offer upon the subject.

It will require two hands to feed an apron, where the cane is in bundles and in rick at a distance not exceeding seventy-five feet, but if dumped within ten or fifteen feet, one active hand can do it and grind fast enough for making forty gallons per hour. One man, with a cart or dumping wagon, could haul, a distance of two hundred yards, a full supply for the mill, The juice being elevated by steam-power pump to the reservoir, one man can attend the temper tanks and the defecator, where one is used, or the fire-pan, in case no defecator is employed. One man at the "strike," or steam-pan ; one more on the floor to measure syrup, clean tanks, etc., and an engineer who does his own firing. It will require a horse and cart, with a man, to remove the bagasse, unless there is

erected a furnace for burning it, in which case one man to attend the fire, independent of the engineer, as the furnace will require some extra attention. Thus there will be, in a full crew, eight men, independent of any yard hands for setting up cane, clerking, or managing the scum for any of the purposes to which it may be appropriated.

The mill being set in motion as early as possible, there will be juice in a few minutes to fill one of the tempers, which should hold enough to fill the defecator, and allow a few inches in the former for agitation, without slopping over, as the lime should be well mingled. The lime tub, of course, should be stationed hard-by the tempers. Provision should be made for filling and discharging these expeditiously, by the use of large openings. The tempers should have a convenient arrangement for discharging their settlings and the washings of the reservoir, which latter will require a daily ablution at least, and when left idle, even over night, in warm weather, they should be cleaned out and a whitewashing of lime applied; this can be done most conveniently with a new corn broom, an untensil quite useful in a sugar works in washing tanks or pans. It will be recollected that the litmus paper is used in the liming process. Care will have to be taken to protect the paper from the steam, only taking to the works enough for the day's use. I have had it destroyed in my pocket during the damp weather, when the steam was thick in the boiling room.

In the use of the steam defecator, it will be found that the first blanket of scum should be removed as soon as it shows evidence of cracking; at this time the steam should be nearly shut off, leaving on only enough to keep up an ascending tendency to the scum,

but not enough to produce ebullition or foaming. A second and third blanket, in like manner, can be taken off. These manipulations may be continued according to the time afforded by the evaporators, which must be kept well supplied by the batches from the defecator.

The use of a steam defecator will also require a tank, into which the defecated batch can be struck, and from which the fire-pan can be supplied. As the estimate has been predicated upon a rate of forty gallons per hour, it will take about four hundred gallons of juice to produce it, and as it takes about thirty minutes to defecate a batch, it will, therefore, require temper tanks, defecators, etc., of two hundred gallons capacity. Tanks, three feet wide, twelve long, and filled ten inches deep, will about meet the requirements, and be of very convenient proportions. If the defecator is some six inches more elevated on the sides and at the front end, than at the skimming end, it will secure againt boiling over, which is a circumstance quite liable to occur, especially if the operator's attention is diverted at the moment of of high heat; but by this arrangement the flow will be run into the scum tank, through the trough and spout at the end, which being daily decanted and returned, will prevent any loss. The scum from the fire-pan may be turned into the same tank, and thus decanted together. It may be found a better method in cleaning up the works to place these decantations together, with the entire scum from the strike into the latter (the strike,) and make one batch of whatever quality it will produce; even if inferior, it had better be by itself than commingled with several batches.

I discussed this subject in my communication to the

Commissioner of Patents, as published in the *Reports* for 1861, upon page 299, as follows:

In the evaporating houses of Louisiana it is most common to use a series of five large kettles, arranged in a train over a flue. The kettles vary in size from eight feet in diameter down to four; sometimes the train consists of six kettles. The train of pans or kettles occupies a space of about thirty feet, and the construction of the furnace and flue beneath is such as to admit of the whole range being wrapped in a volume of flame, which gives of an intense heat. The largest pan of the series, having a capacity of, say, three hundred gallons, is placed at the greatest distance from the furnace, while the successively smaller pans are arranged so as each to approach nearer to the source of heat, until the smallest part of the series is placed directly over the fire.

The operation of evaporation is, in the North, in most cases, conducted by the use of shallow pans, and, for the most part, these answer a good purpose; but from the fact that the manufacture of syrup from the Sorghum has been hitherto regarded in the light of an experiment rather than as a tried and safe investment, the pans and other utensils have generally been of a slight and unenduring construction, and the *fixtures*, from their slightness and *portability*, have been anything but that which they were designated. Now, however, we may, without presumption, look upon the experiment as successful, and may prudently advise that the works and machinery be constructed in a more substantial manner; although, perhaps, upon a scale of dimensions smaller than those of the South, with a view to economy of arrangement and duration.

Two main objects should be borne in mind in the

construction and placing of the pans, or evaporators, viz.: to use up all the heat of the furnace, and to give full employment to the attendant. I made one pan, for experiment, twelve feet in length, and three feet in width, thus exposing a superficies of thirty square feet to the fire; yet I found that the flame from the furnace passed ten feet beyond the pan, and then, entering the flue of a steam boiler twenty-six feet long, soon raised steam therein, and in its mate, to four pounds pressure.

It is very common to use thin, galvanized, or plain sheet-iron for the bottoms, and plank sides for evaporators; yet, however well they may answer the purpose of experiment, they are subject to too many accidents and strains to serve an economical, permanent purpose. When of sufficient length for large batches, the expansion of the iron is so great as to cause a displacement on the walls, destroy the fastenings, and cause leakage; and in addition, the rust of one or two seasons will destroy entirely its integrity.

With two such pans, viz.: a "grand," four feet wide by thirty long, and a "strike," twenty-four inches wide by twenty feet long, each well set on a proper furnace and properly attended, three hundred gallons of syrup may be turned out in each ten hours, with a consumption of, say, three cords of wood.

Inasmuch as this business is very soon to take a more substantial form, by which, instead of patches, full field crops are to be cultivated, and works be required to run early and late in the season, especial pains should be taken to grow some portion, at least, of the crop not only of an early variety, like the Nee-a-za-na and Oom-see-a-na, but adopt every means possible to advance the crop. If the boiling could com-

mence by the 10th of September, all the better, especially if competition opens strongly with the Southern product, as, by that means, some sixty or ninety days may be gained in entering the market ahead of the competition.

Contracts should be made for crops of raw syrup in advance of manufacturing, it could then be made to suit the purchaser; for instance, a refiner wants to start up his establishment; it is very important that he should have an assurance of a supply, and one hundred barrels are not a very large stock for daily consumption, and it is quite a loss to have to suspend every few days for the want of a supply of raw syrup.

It may be well sometimes to read old books, to see how the experiences of to-day accord with the past. I here quote a few pages from G. R. Porter, on the Sugar-cane, published at Philadelphia, in 1831. The matter quoted is taken by the author from the writings of Dr. Dutrone, one of those French authors held in high and well deserved estimation.

"In order to exhibit the relative proportions of water and syrup, we give the following table, taken from Dr. Dutrone's work, an authority which we have uniformly found so accurate that we do not hesitate to take this table as a guide. It is constructed from experiments made with solutions of very *pure* sugar, taken at all degrees of the saccharometer. By means of the saccharometer and this table, the proportion of sugar contained in the expressed juice may be immediately ascertained, and the quantity of water which must be evaporated to bring it to the point of saturation, can be accurately determined. It will also enable us to judge, by approximation, of the propor

tion of water and soluble matter contained in juices of middling and bad qualities.

"The saccharometer is a very simple but useful instrument for ascertaining the specific gravities of fluids; we believe it is very rarely employed in our colonies. If it were adopted, the operator could not fail to find in it the means of conducting the process of sugar-boiling with greater certainty and precision than without its assistance. The saccharometer invented by Monsieur Baume, is frequently used in the sugar refineries of England as well as of France.

"The table shows the quantity of sugar contained in one hundred pounds of expressed cane juice, or syrup, of good quality, and also of the quantity of water that must be evaporated, to reduce the same to the state of saturated syrup, at each degree.

TABLE.

Scale of Baume's Degrees.	Weight of Sugar in each 100 lbs. juice or syrup.			Wt. of Water in each 100 lbs. juice or syrup, beyond the water of solution			Specific gravities of solution at each Degree.			
	lbs.	oz.	dr.	lbs.	oz.	dr.	Deg	Sp. gr	Deg	Sp. gr
1	1	13	6	97	..	15	1	1006	35	1312
2	3	10	12	94	1	14	2	1013	36	1324
3	5	8	3	91	2	13	3	1020	37	1336
4	7	5	10	88	3	12	4	1028	38	1349
5	9	3	..	85	4	11	5	1035	39	1361
6	11	..	7	82	5	10	6	1042	40	1374
7	12	13	14	79	6	9	7	1050	41	1386
8	14	11	4	76	7	8	8	1058	42	1400
9	16	8	11	73	8	7	9	1065	43	1413
10	18	6	1	70	9	6	10	1073	44	1427
11	20	3	8	67	10	5	11	1081	45	1441
12	22	..	15	64	11	4	12	1090	46	1456
13	23	14	5	61	12	3	13	1100	47	1470
14	25	11	12	58	13	3	14	1106	48	1485
15	27	9	2	55	14	1	15	1114	49	1500
16	29	6	9	52	15	1	16	1125	50	1515
17	31	4	..	50	..		17	1132	55	1618
18	33	1	6	47		15	18	1140		
19	34	14	13	44	1	14	19	1148		
20	36	12	3	41	2	13	20	1157		
21	38	9	10	38	3	12	21	1167		
22	40	7	1	35	4	11	22	1176		
23	42	4	7	32	5	10	23	1186		
24	44	1	14	29	6	9	24	1195		
25	45	15	4	26	7	8	25	1205		
26	47	12	11	23	8	7	26	1215		
27	49	10	1	20	9	6	27	1225		
28	51	7	8	17	10	5	28	1235		
29	53	4	15	14	11	4	29	1246		
30	55	2	5	11	12	3	30	1256		
31	56	15	12	8	13	2	31	1267		
32	58	13	3	5	14	1	32	1278		
33	60	10	9	2	15	..	33	1289		
34	62	8	..				34	1301		

"A saturated solution of very pure sugar contains five parts of sugar and three parts of water This is indicated by 34 degrees of Baume's saccharometer, at the temperature of 82 degrees Fahr."

CHAPTER X.

SUGAR-MAKING PROCESS.

Embracing Reports of Tests of Sugar on Exhibition at late Convention.

To make sugar from these canes is the great object of our endeavors. Although syrup and the other products are valuable, and will sustain the crop, as it has done thus far, as one of the staples or our country, nevertheless, to make it a complete success, beyond the possibility of doubt or drawback, it requires only the attainment of this culminating point to effect that object. The signs of the times give us the most flattering prospects of our attaining the summit of our hopes, for, in all directions, we hear reports, and see the samples, of sugar made. They are not the result of scientific laboratory experiment alone, but are the fruits of the labors of a multitude of inexperienced operators, in all parts of the country, and form the product of various soils. Neither are they especially the result of any one particular process or set of fixtures, but from all—the most simple as well as the complex. These considerations offer us one of the best evidences of ultimate success that can well be recorded. Although there is yet some dispute as to

the particular character and relative value of the sugar produced from these canes,* nevertheless, it is sugar, *cane* sugar, susceptible of improvement and making refined white sugar.

I find that, in nearly all cases, where I have traced up the process of the manufacture, many of the principles found requisite in the manufacture of other cane sugar have been wholly disregarded in the processes employed in the production of such sugar as we generally have exhibited at conventions and fairs. That, however, made by Mr. Lovering, of Philadelphia, is an exception, as will be seen by reading his account in another part of this chapter as well as that at our late convention.

I shall give quotations from several authors, and processes in sugar making, for the purpose of affording those engaging in the business an opportunity of considering the subject more generally than by a limited knowledge. It is an unfortunate mistake that some make, who avoid all reading or discussions upon the subject of research, for fear they will not have the satisfaction of claiming for their success, that "no one told them any thing about it;" and if you ask if they have read any thing upon the subject, they will at once straighten up, with a wonderful degree of satisfaction, and tell you that they "*don't take any paper.*"

Very many persons endeavor to obtain patents upon supposed inventions of theirs, which, upon examination, are found to have been long in use. I find this also the case in this sugar works. In reading the old works upon the subject, I find arrangements in the

* The Polaroscopic tests reported by Mr. Geo. C. W. Belcher in another part of this work, clearly settles the question of the value of this cane sugar as now being produced.

construction of apparatus, patented in England forty years since, and now embraced in works, and patented within the last twenty years in this country. More reading and discussion will not only advance this enterprise, but save much money and disappointment. I have been applied to for instruction in sugar making by persons who admitted they had never made a single gallon of syrup. A person may as well expect to learn to read without a knowledge of the alphabet. Those, therefore, who expect to make sugar, will find themselves upon the direct road, when learning to make good syrup; hence all that has been written upon the subject of syrup making will apply here without recapitulation.

The great object should be, first, to obtain that variety of cane that has proved to be most successful in crystallization; then cultivate it with great care, and, in gathering, reject the unripe and inferior canes; cut and use only about two-thirds of the stock, cutting off the butt, about six or eight inches from the ground. Then, in milling, I would not press it extremely hard, as it is admitted, in the South, that the very hard-pressed cane does not make so fair an article of sugar as light-pressed. This, however, should be more thoroughly tested. Mr. Lovering, it will be seen, expressed his in a hand-mill, and admits he did not get all his juice out.

It will be perceived, in several extracts in this chapter, that the great obstacle to the formation of crystals exist in the foreign matter contained in the syrup. It is not only acid, but feculencies, gum, etc. These should be removed as early in the process as possible, lest, in their chemical action, when heated to a high degree, they convert the crystalline properties of the

sugar into what is termed grape sugar or glucose. similar to candied honey.

The only entirely dry, bright, and natural sugar, free from all guminess, that has come under my observation, as made from these canes, was that made by Mr. Lovering, and the specimen that Mr. Wray brought to this country, although I have seen numerous other specimens, equally fair, posessing good crystals, but not free from foreign substances, and adhesive. It will be observed that Mr. Lovering filtered all his syrup, while only partly inspissated, through bone-coal. It will be also observed that he invariably fully neutralized with lime, and afterward in the process used clear lime-water, which is, of course, very weak, as water will only hold in solution one seven hundredth part of its weight of lime; but this he tells us assisted in coagulating the vegetable albumen; this he added when his batch had attained a temperature of 225° F., which is about 28° B., as near as I can judge from my imperfect observations upon the thermometer.*

The experienced eye, and the use of the saccharometer, for limited operations, will be found more safe,

* The use of a thermometer is, no doubt, a correct method, provided it has been well tested and its standard determined. The small ones, in ordinary use, are difficult to use reliably in our open pan boiling. I boiled one batch to 233 degrees, and found it quite too thick. I find in Mr Lovering's experiments, he boiled down to 230 degrees and sometimes 246 degrees F. This, in a measure, is explained by reference to the table at the close of this chapter, where it will be seen that a solution of pure sugar will sustain a greater heat, without injury, than those solutions having feculencies, of any kind, hence the importance of thorough and complete defecation before attempting to make sugar. Mr Kennys's syrup that was not granulated was very bright, and free of feculence showing his work to have been well done though too low for best results.

but, in well-arranged works, and good instruments, with careful operators, the thermometer will unqestionably, be the most accurate gauge to go by. The table at the close of this chapter will afford instruction to those operating upon a close, careful scale. It, however, has been predicated, as will be seen upon experiments made upon pure sugar in solution, hence, where there are other properties in the solution, this will not hold good, affording only approximate results, instead of actual.

I have been asked a thousand times why more attention is not given to sugar making from this cane. It is not in the nature of things that such should be the case, so long as there is not a surplus of the syrup produced, by which its price will be reduced so that sugar-making will pay better than syrup-making; besides, confidence in the crop must be more fully established, in order to induce capitalists to invest in the business, whereby all the buildings and apparatus required for a successful establishment may be provided.

For the guidance of those intending to experiment in sugar making, the following brief sketch of the Louisiana sugar-house may be of use, as indicating the kind of arrangements necessary to be made. In addition to the buildings already described, there is a large room into which the cooling or granulating vats are conveyed from the boiling-house on a tram-way. The vats are about six feet long, two feet wide, and one foot deep, and the room into which they are conveyed is kept warm. Here they remain until granulation is completed, when hogsheads are brought on trucks and filled with the sugar; thence, the hogsheads, filled with the moist sugar, are wheeled off to the "purgery." The purgery is a building equally spa-

cious as the granulating room, and is open-floored, with strong timbers, set at such distances apart as to receive the hogsheads on two of them. The molasses, as it drains from the hogsheads, runs on to the earthen floor below the timbers, and is conveyed by falls to a large, cement cistern in one part of the ground. Often the purgery is large enough to contain two and three hundred hogsheads.

In our colder Northern climate both the granulating and purging rooms will require to be closed in, so as to secure an equable temperature throughout the working season in all the changes of the weather.

It is one of the characteristics of this cane syrup to granulate slow, and that which is the slowest in forming appears the most satisfactory when formed. In the two barrels sent me by Mr. Kenny, the one was well granulated before shipping while the other he shipped as syrup, although I found some crystals in it on its arrival. I kept them in my factory, a very cold place, only fire in daytime, nevertheless the syrup continued steadily forming crystals which precipitated and has given us some of our best samples of sugar when swung in the centrifugal. From this, freshly taken, Mr. Belcher reports polarization 89 per cent. Some samples have polarized higher but those had been longer taken, and, hence dried out before polarizing. Now, unless by cultivation or some improved method of manufacture, we are enabled to obtain a speedy granulation, there will occur a stubborn difficulty in this business that will be very hard to encounter, that is to provide suitable and safe granulating rooms in these cold climates. This consideration gave me much anxiety until recently when a plan of underground tanking occurred to me, which, upon investigation, I

find entirely feasible and cheap. I have submitted it to Messrs. Belcher and also to Mr. Dougherty of Louisiana, all of whom agree in its practicabiity and propriety.

The tanks should be sunken like tan vats, in the ground of the boiling-room, and of such size and depth as the extent of the works may call for. Into these the finished sugar can be turned hot, having the superfices of tanks such that each strike would only put in a layer of two inches, which would cool in time for the next, or, as Mr. Dougherty suggests, the discharge of the battery could be alternated from one to another as the case may require. These tanks should be well covered on the level of, and constitute the floor of the boiling-room, each having a suitable man-hole or hatch, so arranged that it can be closed entirely against any access of foreign sustances. After the season of working is over the covering or the floor may be further covered with a fire-proof coating of clay or sand, so that should the building burn down, the sugar would be safe.

Now, in the filling of these vats it will be very easy to do in such manner as to have them, when full, retain just that degree of heat that may be desired, say about 140°. F., then, being covered, and all the surroundings warm, it will necessarily retain much of this heat for many days, during which time tbe process of crystalization and precipitation of the same will have begun, and after that there is no trouble to be apprehended.

It is a good indication when the crystals form and settle through the body of the syrup, as this proves that the same is not full of gum or mucilage that is a hindrance to the aggregation of crystals as well as the precipitation when formed.

Now, by having a gas-pipe opening through the lid, a staff may be dropped in at pleasure to determine the progress of crystallization, and as soon as it appears to be completed, then the work of centrifugal purging may commence by first pumping off the molasses from the surface, which it will be well to swing through the centrifugal and thus free it from all impurities or specks, and then take off the hatch and take out the sugar and prepare it for the swing, which consists in warming it to about 100° F. This can be done by having a warm bath to set some tin vessel having the melado in, and stirring it gently until the right temperature is obtained.

Care should be taken not to have the bath too hot, lest the crystals next to the tin should be over-heated and dissolved, and in like manner, by too much stirring, the same result will follow.

The room in which this is done should be warm, say 85 to 90°, as cold air being drawn through the sugar in the centrifugal will chill the molasses and retard the drying. Those using a finishing pan or battery will find it well suited for heating water as a bath for warming the melado should it need it. It may result that it is not needed.

Another benefit will result from this fire, the warming of the purgery, as we may now term this room, (temporarily). It may become necessary to put up some temporary partitions to make this room warm.

It will be perceived that the plan discussed is such that it may be adapted to any sized works, simply by an addition of tank capacity. I am inclined to think that the use of this tank arrangement will be found economical, even in the syrup business, especially

where large quantities are made and need storage for some few months.

The first cost of such tank will be from 50 to 60 cts. per barrel. Then syrup stored in them warm will mix and thus produce large lots of uniform grade, and having time to settle, all the heavy impurities will precipitate, and the floating parts can be removed by running it through the centrifugal, thus affording a pure and uniform article of known standard.

Parties fitting up as new beginners, by providing themselves with this plan of coolers, they are then prepared to make syrup or sugar as their cane shall justify. But, if they defer until the season for working has come, then it will be difficult to effect it, and they will be in the predicament that our honorable friend in Minnesota was last fall, with his melado hard and fast in his barrels and theromometer far below zero, and himself off to St. Paul in obedience to the voice of his constituents.

There is as much to be feared from a lack of skill and the requisite preparation for this business as from any inherent obstacles in the cane itself. If you were to select a coach driver that could run his carriage so close to a slight buggy, on one side, as to cause the occupants to shudder, and on the other, touch the parasol of a fifth avenue belle, and put him at the helm of a Cunard steamer bound for Europe, he would very likely run over several small vessels and bring up on Governor's or Staten Island with a crash.

It will be found to employ two hands very profitably at this work, one to work the machine (if a hand one), and the other to prepare the next charge and alternate on the crank, which is most laborious. Each charge, however, will require only about fifteen min-

utes if the melado is in good condition. A barrel can be set in such position as to have the molasses run from the machine directly into it.

By this method of running a sugar-works there will be much labor saved in attending the operations during the boiling season, and a relief from the annoyances of barrels leaking and hoop-driving, and then the hand ling of coolers upon trucks is quite a task and subject to some mishaps also. In fact, I see no other way to get along with this feature of the business in a systematic and profitable manner. This is the nearest approach we can make to the well-tried methods of Louisiana. If we had their climate and cane to handle we could do as they do. In this matter we are compelled to bring down the plans of those large works to our wants and conditions, in the same manner that I, many years ago, brought down thier massive mill and then set it on end for horse-power.

Should plans for such tank be needed, I can furnish them on short notice. The size of works should be determined first, *i. e.*, the number of gallons syrup per day and total per annum.

The foregoing descriptions of the methods and processes in the South, may serve to familiarize the minds of those engaging in the buisness North, for (as before intimated) the deficiency of a well-settled plan of operations, with provisions for executing it, will be the most common obstacle to success. These conditions obtained, and a thorough defecation of the juice secured, before reaching 25° B., with the juices of mature cane, whose juices mark 10° and upward, sugar will invariably be obtained that will purge of its molasses readily, by the use of the centrifugal if not by the usual process.

By a thorough defecation, I mean not merely fair in color, but bright and transparent, when seen in considerable body. If feculencies remain in it much beyond that degree (25), the heat will soon become so much greater in the syrup, that many parts of it will become carbonized, especially all starchy matter; as a baker's oven, when heated sufficiently to bake crackers, will not raise the mercury in a thermometer suspended in the heated air, above 190°, and this degree even will soon blacken bread. These considerations lead us to the conclusions that the principal coloring of the syrup arises from a scorching effect of the high degree of heat requisite to convert the water of solution in the sugar into vapor, and expel it from the boiling batch.

In addition to what has been said upon the subject of defecating, in previous chapters, I will further remark, that I find, in examining the processes employed by the English, French, and Spanish in the West Indies, even as late as 1830, that they had obtained no reliable practical test by which to be guided in the use of lime or temper, as they call it; being governed by the eye of its effect upon the boiling syrup, putting installments in at various stages of the process, the general conclusion being that it served to separate the feculencies, considerable dispute or doubt being entertained about the existence of a free acid present in the juice. The use of litmus paper is nowhere spoken of. Dr. Dutrone sometimes intimates that lime may be prejudicial to the quality of sugar, but still, for some cause, seems compelled to use it. Had he been as well satisfied of the presence of the acid, as the application of test-paper would give, the use of the lime would no doubt have been more scientifically

applied. It would appear to be a better method to use it in the cold juice (as before indicated) than to allow the action of heat upon the acid in combination with all the properties contained in the fresh juice, by which new combinations may be formed, more difficult to remove than the original.

The above are from my observations as contained in my work of 1863, and are in conflict with Mr. Schwarz's later observations, though in harmony with Mr. Dougherty, as applied to southern cane, which may differ enough to justify Mr. S. in his position.

With a view to learn if there had been any essential change in the method of treating cane juice in the process of sugar-making in Louisiana I addressed several letters to my valued old friend, John A. Dougherty, an experienced planter and careful observer of that State, whose replies I am permitted to use, and do it in connection with sugar-making to which they relate.

MR. DOUGHERTY'S LETTERS.

"Your letter is before me and I am glad to read it, though what is meant by the "Northern Cane-Growers Association is a mystery to me.

"There are many improvements since you were here, both in cultivation of cane and making of sugar; and though many of the large planters are not doing business to the extent of the capacity of the plantations, many of the old cotton planters are making sugar with horse mills and evaporators of various styles, though much the same as Cook's.

"These small planters are doing well, because the labor is in the family and can be used to better advantage in sugar than in cotton.

"This season has been good for all farmers and

though sugar is low in price, it is much higher in proportion than any other produce, and gives in some cases that I know of, as much as seventy-five to eighty dollars profit per acre.

"These small places are on the high lands in this and other parishes, and are increasing in number just around us; so much so that a man is about to erect a mill and make the sugar on shares, within four miles of the town.

"The tendency of the large planters is towards the use of steam in making sugar, instead of kettles, including vacuum pans; the use of the polariscope and improved methods generally producing more and better sugar, and consequently less molasses and of inferior quality. The outlook for sugar planters is good, seeing that the refiners will be unable to produce a really good article for less than 8 3-4 to 9 cents, if they can be prevented cheating the Government in their importation of foreign and very inferior sugars.

"This country is improving slowly, and there is an opening here for good men with some money. There is no trouble about politics, and negroes care less about voting every year as it generally makes them lose a day and gain nothing.

Yours respectfully

JNO. A. DOUGHERTY."

"I have the pleasure to own receipt of yours of 20th with sample of sugar. This sample compares favorably with what is called "seconds," that is, sugars made in vacuum pans from the molasses of the first sugars.

"The whole manufacture is done on the "Cook" pan, and it runs a constant stream of sugar into cool-

ers, changing coolers as becomes necessary, as it is better to run the sugar only to 3 or 4 inches in depth, then paddle it gently and again and again at intervals of 20 or 30 minutes until it is granulated, when you can run the sugar again into the same cooler.

"A trough is used to convey the sugar from the pan to any desired cooler.

"It is desirable to have three or more vessels to receive the juice from the mill, so as to give time to effect perfect clarification, and with lime water and litmus paper you are ready for work.

"The "Cook" pan, throws the scum to the sides when boiling, and it must be removed at once.

"If you wish to granulate on a separate pan, I would recommend that you discharge the cero at about 30° and let it settle two or more hours before granulating it."

"You lose the heat, but you also get rid of a deal of dirt. Your copper boiler must be removed from the fire and have time to cool, before it is filled again, as otherwise it will burn the cero.

"The clarification is the main point, and with cane juice it has never been done perfectly without sulphurous acid, bone black or filters of some kind; and steam is preferable to a wood fire for the reason that it can be shut off at any moment, and the best heat to assist in cleaning cane juice is 210° to 212°, then skim—then boil up again and skim again. The impurities that don't rise to the top, if time is given, cannot be got out with heat, and that is the reason that it pays to allow the cero to settle awhile before passing it to the granulating pan.

"This gives three chances to clarify, viz.; 1st when

lime is applied to the green juice—this causes a precipitation of some impurities—2nd, when it has just reached the boiling point 212°—3d, when it has concentrated to 26° or 30° and this will also be by precipitation.

"A sugar boiler from Belcher's refinery could give you many little tests that will be useful. An iron pan is made and used here, with partitions, deeper than the "Cook" pan, and the juice is dipped from one partition to another and finally thrown off, similar to open kettles.

"I am of the opinion that if there is sugar in this Sorgho, it will be obtained by boiling in vacuo cheaper than by other plans, which will give a larger and firmer grain that will permit the use of centrifugals to separate the molasses.

"The first attempts may not prove profitable, but if sugar can be got from beets in paying quantity, it is only a question of time when the Sorgho will be recognized as a sugar-producing plant.

"Our country produces grain and meat enough to almost feed the world, and it will be a glorious day when we can produce enough sugar to feed our people, and I think the time is approaching.

"Yours respectfully,

"JOHN A. DOUGHERTY."

"Yours of the 20th and 22nd, and a copy of the Agriculturist are before me.

"The books and the sugar-makers agree that lime is the best medium for the defecation of cane juice.

"It is prepared as if for white-washing only the lime is carefully sifted, and juice added instead of water.

"To a certain known quantity of juice you introduce a

known quantity of lime in a glass vessel. Set it aside and let it settle. Begin with a small quantity of lime. If it looks bright and clear it is about right, and should be a little acid.

"You should have several vessels to receive the juice from the mill, and as they are filled the lime is added in the proportion ascertained by the experiment, well incorporated and allowed to settle, and then it is ready for the pan. In the Cook pan the dirt flows to the sides of the pan and must be removed at once.

"When the pan is put in operation, you fill all the apartments before starting the fire, and then skim all of them, but in the further progress of the work the juice must be perfectly cleaned before passing from the second compartment. The lime is used in the receivers only, and with care and in using litmus paper there is no trouble.

"It will be better to granulate in another vessel, and your plan is good, but if you have access to steam you could arrange a wash tub with a coil of 1 1-2 or 2 inch pipe to do the business much better, and in either case the syrup should be allowed to settle before going to the granulating pan, and the thinner it is the quicker it will settle. With cane juice this operation is considered very important, as the stuff that is precipitated cannot be got out, in any other way.

"The receptacles for the granulated syrup may be arranged as you propose, but there should be several of them, to allow one strike to commence granulating before another is put on top of it. The crystals form at the bottom and sides, and after they begin to form it is necessary to stir the whole mass slowly, and this repeated several times.

"With cane sugar one strike becomes hard before

another one is thrown upon it, and sometimes there will be one strike each in twenty coolers before the first one is hard enough to be used again.

"Sometimes (from various causes) the whole strike will not granulate, and the top of the cooler will be only molasses, and this is dipped off before the sugar (that is under the molasses) is put into hogsheads.

"Driving the molasses out, with centrifugals is very nice, but is very extravagant, I fear, except when the granulating is done in vacuum pans, which make a grain that can stand the treatment. It must be very wasteful of the sugar made from Sorgho, I think.

"I think I have covered all the points named in your letters except the evaporation by steam, which I will defer until another time. If you send me some of the genuine seed, I will give it a trial here and also save as much seed for you as you may desire.

"I like you to feel that I stand ready to give any information, or to assist in any way to promote your undertaking, and it is no trouble to write letters.

"Yours,

"JOHN A. DOUGHERTY."

It will be perceived by the following letter that I am unable to embrace the steam train in this edition; parties desiring can correspond with me for it.

NOTE.—I have two objects in having Early Amber cane grown far South, first, to have early samples of cane for our expert to polarize for the purpose of noting the progessive development of sugar and at what time it reaches its maximum stage of maturity, which will serve as a guide for our northern cane growers. A second object is to have seed of that latitude for next season's planting in different northern latitudes, as an experiment; and, I may add, a third object, is to be able to determine to what degree different altitudes effect the development of sugar in the same plant.

"I have just received your message, and hasten to reply.

"The steam process alluded to in my letter of 1st inst., will require time to explain, and also drawings, and I am not able just now to take the time from other employment, as we are now very busy in pitching the crop, fencing and ditching.

"Nor will it be applicable to individual sugar-houses although it is the very thing for a sugar-house, to work up the crops of, say fifty or more farmers.

"My idea was, that if this sugar cane proves a success, you could project a "central factory" to work up the canes for the neighbors, for a certain price per pound of the sugar and molasses you would give them as the result of the canes brought to your factory; or that you would purchase the canes delivered to you at a price per ton.

"The experience of this year will enable you to ascertain the value, in money, of a ton of cane, and then you will engage a certain number of crops, at a certain price, for the next year, and then form a company and build the house and engage the machinery to turn the crops into sugar and molasses, which you could do to much better advantage than any person manufacturing a small crop. This will establish the business on a basis that will induce many to raise the cane for sale, who would not think of paying out money to build a house and purchase mills and evaporators.

"The sugar business in this country will eventually take this shape, to the advantage of both the farmer and the sugar-maker. I write in haste, to avail myself of the first mail.

"Yours,

"JNO. A. DOUGHERTY."

I here introduce the letter or report of our esteemed friend, Hon. Seth H. Kenney, upon the cultivation, manufacture, &c., of the sugar and syrup that has afforded us so much satisfaction, and about which I have made frequent reference in this work.

Although some portions should have appeared in other chapters, I thought best to place it together, as it will be better understood; besides, I could not do otherwise, as, by mishap in the mailing, it failed to reach me until my printer had closed up, and stereotyped the book to this chapter.

It will be perceived by his report, that the soil and culture was favorable, but the season was not so. The cane, not well matured, was allowed to rest some three weeks after cutting in the field, was thoroughly pressed and boiled with all the free acid present left in it and finished by the eye-test, *i. e.* dripping from the skimmer or ladle, (which is, by far, too indefinite) and again, it will be found quite difficult, as Mr. Schwarz says, (as he used the same kind of evaporator) to finish accurately even with a thermometer, in a flowing current in so shallow a body.

Now, in view of all these conditions and circumstances, I repeat, that these results are a more convincing proof, to me, of the reliability of these canes becoming a paying sugar crop, than any heretofore adduced, and leads me to the full conviction that if all the requirements, set forth in the various discussions and reports contained in this work, are complied with, sugar-making from these canes and also from corn stalks, or corn canes more properly speaking, will crown our efforts with success, and that too without a resort to any expensive or difficult process.

I have very little confidence in the use of any other re-agents than that of common lime and albumen, such as eggs, milk, or the prepared albumen extensively used in refineries for clarifying.

NEW PROCESSES OF SUGAR-MAKING.

It has been my purpose to adhere closely to those methods only that have been well-tried and stood the test of thorough field operations. The many failures in the past that have come under my observation, has caused me to distrust all claims not sustained by well authenticated reports of weights and measures, as in the case of those of Mr. Lovering, and reported in this chapter.

MR. KENNEY'S LETTER.

"I. A. HEDGES: Dear sir;—Yours of the 28th with request concerning the barrels I sent you is at hand.

"I marked out the land three and a half feet each way, which had been plowed and dragged previous, thus planting in check rows 14th and 15th of May.

"Instead of planting in the mark made, I plant on the same side of the mark to avoid getting the seed where a heavy rain might cover it too deep. The soil was formerly timbered land, mostly sugar-maple; it raised nine crops of the old varieties of cane in succession, was then seeded down to wheat and grass seed, timothy and clover; that season it yeilded 25 bushels of wheat per acre. It was seeded to grass five years; two years ago I broke up and planted to corn; had a good crop; last season planted the Amber cane; left from five to six stalks in a hill on an average. As soon as I could follow the rows I dressed around each hill, and soon after went through with a fine tooth cultiva-

tor and continued this cultivation till about three and a half feet high.

"The soil is a sandy loam, clay subsoil; lays high; is not as rich as formerly but the clover and timothy sod made as good a growth as I ever had, the seed was grown in Missouri the year before. There was scarcely any suckers, and the stalks were large and of uniform size but the cane was not; one-half of the seed ripe.

"We had very unfavorable weather the forepart of the season, considerable rain, so that Sept. 20th I feared a freeze and took ten hands and cut and piled six acres in one day. We laid down four hills, butts to the north so the sun would not strike the ends, then crossed the butts of four more hills, crossed and re-crossed so to raise the butts; this was done with the leaves all on end, when finished the butts were the highest, and the tops, when the pile is done, are spread out fan-shape and one-half of a wagon load in one pile. We usually put eight rows in one row of piles, the butts being the highest they shed rain quite well.

"I am careful to have the ends even at the front end or highest end, as if piled part of them so that they stick out beyond the rest, they will sour quicker as far in as they stick out beyond the pile. Piling crosswise at a nearly square angle, with the leaves on, while it lets in air enough to prevent heating or moulding, it does not dry up as bad in this way as in windrows.

"This cane, cut up Sept. 20th, was none of it ground till the 17th of October, when I commenced on it and worked it at the rate of 141 gallons every eighteen hours; the yield averaged 160 gallons per acre, but I

do not think but what better results would have been obtained if the cane had been riper.

"We boiled the juice on No. 7 Cook Evaporator, two persons running it, one to tend the back end and stirring to get it even thickness, the other man to keep a steady fire and skim when the juice has no treatment as ours had none.

"We have found we had a much nicer product if the corn can lay a few days.

"The barrel of syrup I cannot remember, but think it was from corn planted on newer land May 23d, and this was windrowed. I judge of this because not as light color as the sugar. I find the older the land the better the product granulates with me. Almost all my syrup granulated more or less, and many barrels granulated all of it or not more than two or three gallons of syrup on the top.

"I think, from what I have learned, I shall be able to do much better another season. I feel under obligations to farmer Schwarz for suggestions, and find him very valuable help.

"Minnesota contains 83,500 square miles of land. The Early Amber cane thrives as well as Indian corn, and I believe a more thorough knowledge will enable us to make sugar one of the leading industries of the State.

"I am satisfied we need some treatment of the juice to make the business always a success in making sugar. I also think a light and not very rich soil has much to do with making sugar and fine syrup, but the success that is attending men all over this State, convinces me that Minnesota will astonish our Louisiana brethren before long.

"When we run the hot syrup out of the evaporator we run it into a cooler constructed same as the Cook Evaporator; from there into an open-headed barrel while still warm. If a pint of previously grained sugar is stirred in them, barreled up and the bung left out till cool, it will facilitate granulation; standing through till warm weather will granulate that which has not showed much signs of granulation, provided it is thick enough. We usually boil so that it will weigh 13¼ lbs. per gallon when cold. We have the best success in securing granulation after the weather begins to be cool, providing the cane is not soured in the butts. Some lots granulate even in the cooler, while other lots will in afew weeks, some not till warm weather.

"I think to treat the juice properly we can get uniform results. I am glad to learn that there are so many investigating this new industry, and if we do not accomplish something, I shall be mistaken. Wishing you all success, I remain,

"Yours in the sugar interest,

"SETH H. KENNEY."

I can not refrain from repeating here, again, that we must look more to the production and preparation of the cane for good results, than has been generally admitted; Mr. Kenney's letter is valuable in this connection. Let nature do the work if she will; allow the cane to rest after cutting, with the foliage on it, suitably protected until the process of maturing has been so complete as to transform the acid and starch of vegetation from glucose into cane sugar, by which not only to increase the latter but remove the obstacles to its crystallization.

I have been favored with the following polarization

of some of the samples of sugar sent to the convention, which speaks well for the northern planter.

"ISAAC A. HEDGES, ESQ.; Dear Sir:—The sample of sugar, manufactured by Prof. Stewart, polarized 86.8; the sample exhibited by Mr. Kenney polarized 94.5. Both samples were very dry, but the tests will show their comparative value within one per cent.

"Very truly yours,

"G. C. W. BELCHER."

The sample of corn-stalk sugar by C. M. Schwarz polarized 92.; the remaining samples were too small to afford a test.

It will be recollected that I have placed much confidence in the plan of subsidence or settling. This is of long standing, and although age is not always a guarantee of excellence, yet, in this case, I think there is reason to believe it is. Dutrone makes it a special provision in his train, recommending eight or ten hours as suitable time for subsiding. He places his syrup at 24° to 28° B., which I conceive to be quite too heavy, unless there has been a previous settling in the process. If inspissated to that degree, it will be so thick that it will require more time to effect the same result, and this will lose more of the heat, consequently, prove a waste of fuel.

It will ever be found difficult to use any kind of bag or cloth filters, except after the juice has been thickened to at least 18° B., and then it will require very complete arrangements and expert operatives, with an abundance of hot water, for washing bags. Coal filters are also attended with too much trouble for new beginners. Hence, if it is found requisite to employ these methods to obtain our sugar from this crop, I

shall expect to see our syrup carefully made and barrelled up at about 24° B., and sold to central establishments, well arranged for the business, where, like our wheat at the flouring mill, it will be more profitably converted into the marketable article, than our country establishments can possibly do.

The practical experiments of Mr. J. S. Lovering, of Philadelphia, Pennsylvania, are, perhaps, more directly to the point, in this chapter, than any thing that we can quote at this time, and although they have been often published, nevertheless, very many may read them here for the first time.

Mr. J. S. Lovering's experiments with the cane, made in the fall of 1857, were continued, at different periods, from September 28th to November 27th, making a series of seven experiments, all of which were upon a small scale, making some fifteen or twenty pounds gross on each occasion. The several tests made proved a gradual increase of saccharine, as also of sugar, until the fifth experiment, on the 9th of November, at which time the weather became quite warm, thermometer 74°; this succeeding several days of frosty weather, soon deteriorated the quality of the cane; from this, however, he made a fine article of white sugar, directly from the cane, but in quantity much less than some of his former experiments; but he found it requisite to pass this syrup through double the quantity of coal to obtain the same results as to color.

By the weights and estimates made by Mr. Lovering of an acre, producing 18,277 canes, which produced 1,847 gallons of juice, weighing nine pounds, avoirdupois, per gallon—16,623 pounds, or sugar, first crop, 5.58 per cent., molasses, 7.14 per cent.; to-

gether, 12.72 per cent. This sugar, says Mr Lovering, was perfectly dry, and worked well at every stage. On the succeeding day he boiled the molasses drained from the above lots, (except that from the tops, it being too poor for re-crystallization,) adding clear lime-water until reduced to 35° B.; when boiling, took off a thick, glutinous scum, and boiled it to 243° Fahrenheit. In two hours he had a copious crop of crystals, and next morning found it quite solid, thus showing that, by a more careful process, a greater amount of sugar may be obtained.

EXTRACTS.

On the 10th of May I planted about half an acre, on upland of good quality, such as would yield, in ordinary seasons, fifty to sixty bushels Indian corn to the acre. The rows four feet apart, and the plants intended to be six inches apart in the rows, but which, on taking off the crop, proved to be a little over seven inches apart. When the canes were about eighteen inches in height, I had the suckers removed. During the month of June I passed the hoe-harrow through it twice, a man following with the hand-hoe, as in the case of Indian corn. It was then left to take care of itself. It grew rapidly and evenly, and attained the height of twelve to fourteen feet.

My apparatus and utensils for conducting the experiments consisted of the following, viz:

A pair of iron rollers, seven inches diameter and twelve inches long, set in a frame one eighth of a inch apart, with spout to catch and collect the juice, and a crank turned by hand; a few sugar moulds and pots; some ivory black or animal carbon: two filters, made of common bed-ticking, in the shape of an elongated pudding bag; a thermometer, Beaume's Pese-Sirop or saccharometer, and a polariscope. All the other utensils I obtained from the kitchen, viz.: a copper kettle of ten gallons capacity, a ladle, some tin pans, bowls, buckets, etc., to contain the juice.

FIRST POLARISCOPIC OBSERVATION.

Sept. 28. Temperature, noon. 71 deg. F. Wind S. W. Clear. Of two canes took the first joints above the stay roots—

1st joint, 9 inches long, weighed	118.854	grammes.
2d " 8 " " "	93.742	"
Weight of first joints of two canes	212.596	"
After passing these three times through the rollers the begasse weighed	64.380	"
Leaving, as weight of juice (69.7 per cent)	148.216	"
Measured the juice, and found 135 fluid grammes—specific gravity	1.063	

After precipitation by basic acetate of lead, of a voluminous green colored flocculent substance, it filtered with dificulty. then completed the decolorization by passing it through animal carbon, and found by first observation in polariscope:

A deflection of the ray, right	27°	29.7 right.
Add 10 per cent for ddution by precipitant..	2°.7	
After inversion by H. Cl. left	12° 0	temperature 27°, 13.2 left.
Add 10 per cent as above	1°.2	
Sum of inversion		42.9

This sum of inversion, (42.9) at temperature 27 deg., indicates 54.35 grammes of pure dry sugar to the litre of juice, and by reference to past results it is found that 204.24 grammes of sugar per litre, equal 18.82 grammes per 100. or 18.82 per cent. Then, as 204.24 : 18 82 :: 54.35 : 5.008 per cent. of sugar in the juice, and as 100 : 5.008 :: 69.7 : 3.49 per cent. of sugar in the cane. A second observation in polariscope, of the juice from the two joints of the same canes next above these, indicated 5.57 per cent. of sugar in the juice, proving them to be richer than those nearer the ground.

FIRST PRACTICAL EXPERIMENT.

Sept. 30. Temperature 8 A. M. 40 deg., M. 66 deg. The fact of the presence of crystallizable sugar in the cane being established, I proceeded to cut and grind twenty feet of a row, and passed the thirty canes which it produced three times through the rollers; about one-fourth of the seed had changed to a dark glistening brown color, but was still milky; the remainder was quite green; ground six or eight of the lower joints, which together yielded three

and a half gallons of juice, weighing 9 deg. Beaume; neutralized the free acid by adding milk of lime: clarified with eggs and boiled it down to 240 deg. Fahrenheit.

This first experiment looked discouraging and unpromising at every step; its product was a very dark, thick, viscid mass, apparently a caput mortuum; it stood six days without the sign of a crystal, when it was placed over a flue and kept warm four days longer, when I found a pretty good crop of soft crystals, the whole very similar to the "Melada," obtained from Cuba, but of darker color.

SECOND EXPERIMENT.

Oct. 13. Temperature 8 A. M. 50 deg , M. 72 deg. S. E. cloudy. About two weeks having elapsed since the first experiment, the weather in the interim having been quite warm, temperature at 8 A. M. 40 deg. to 52 deg., and at noon 66 deg. to 75 deg. Fahrenheit; and about one-half the seed being ripe, I determined to try it again, but not being very sanguine of success, no polariscopic observation was taken.

Cut and ground fifty feet of a row, which produced eighty eight canes, and yielded eight gallons of juice, weighing 10 deg. Beaume (one degree more than the previous cutting), from the six and seven lower joints; juice slightly acid. First clarification four and three quarter gallons, neutralized with three tablespoonsful of milk of lime, stirred in one pound fine bone black, and three eggs, and placed it over a slow fire; at 215 degrees Fahrenheit took off a very dense, thick, green scum; when at 162 degrees Fahrenheit it marked 7½ degrees Beaume.

A second parcel of juice from this grinding (three and a quarter gallons) was treated in the same manner, and set aside, both having been first boiled down to 22 degrees Beaume.

Oct. 14. Temperature 8 A. M. 54 deg. noon 70 deg. N. W. clear. Cut and ground fifty feet; eighty-one canes, produced seven and a quarter gallons juice, 10 degrees Beaume, which was treated as above, except that the eggs were omitted.

Oct 15. Temperature 8 A. M. 50 degrees, noon 70 degrees. N. E. heavy rain. Cut and ground fifty feet, produced eight and a quarter gallons juice, weighing 10 degrees Beaume.

Oct. 16. Temperature 8 A. M. 46 degrees, noon 60 degrees. N. W. stormy. Cut and ground fifty feet, eighty-six canes, eight and three-eighths gallons, 10 degrees Beaume.

The whole of the foregoing four parcels were at this stage of the process concentrated to 22 deg. Beaume, and set aside until I had completed the series on the 21st October: they were then collected together and again clarified with eggs, and a second scum taken off; they were then again placed over the fire, and when at the temperature of 225 degrees Fahrenheit, clear lime water in small quantities was added to coagulate the vegetable albumen, which is not disengaged at a lower temperature, but which is then observed as a whitish scum, very tenacious and glutinous, and is very detrimental to crystallization. After the various delays, heating and re-heatings consequent on my limited means of working, (the great disadvantage of which, those acquainted with the subject only can appreciate,) I commenced filtering the whole, but found it so ropy and glutinous that it would not pass through; diluted it to 10 deg. Beaume, when it came through tolerably bright; then passed it through five feet of animal black; it parted with its its coloring matter very freely.

Oct. 22. Temperature 8 A. M. 32 deg., noon 50 degrees. S W. clear. Divided the product into three parts, and boiled it as follows:

First part to 230 deg. Fahrenheit. This stood an hour without crystallizing; found it too low, although the thumb and finger proof indicated otherwise.

Second part to 246 degrees Fahrenheit; which was added to the first, and in a few minutes crystals began to appear.

Third part to 238 degrees; being the mean of the other two. On finishing this, the two preceding had formed a thick, opaque mass of good crystals.

Filled one mould, weight 20 lbs		
Weight of mould, - - 4¾		
		net weight 15¼ lbs.
Filled one mould, - 14¼ lbs.		
Mould - - - 4¾		
		" " 10 lbs
Total net weight, - - - - - - -		25¼ lbs.

and next morning set them on pots to drain. Also boiled down the juice from the tops, four and three quarters gallons, which produced with the scum thirteen and a half pounds molasses.

Nov. 2. Temperature 8 A. M. 46 deg., noon 60 deg. S. W. clear. Knocked out the proceeds of this experiment with the following results, viz :

1 mould, gross weight, 20 lbs.				
tare,	4¾ "			
	net weight 15¼ lbs.			
weight of molasses,	8¼			
	net weight 7 lbs.	Sugar.	Molasses.	
1 " gross weight, 14¼ lbs.				
tare,	4¼ "			
	net weight 10 lbs.			
weight of molasses,	5¼			
	net weight 4¼ lbs.		5¼ lbs	
Add molasses made from the tops, as above,			13¼ lbs.	
Total weight of product of two hundred feet of a row,	lbs.	11.50	27.25	
Fifty rows, four feet apart and two hundred and eighteen feet long, constitute an acre, and two hundred feet of a row is less than one fiftieth part of an acre by eighteen feet, therefore add pro rata,		1.03	2.45	
Product of one fiftieth part of an acre in lbs.		12.53	29.70	
Multiply by		50	50	
Product of an acre in lbs.		625.50	1485.00	

A gallon of molasses weighs twelve pounds, therefore, divide 1485 by 12, and we have, gallons, 123.75.

For the acre 625½ pounds sugar, and 123¾ gallons molasses, produced from 18,148 canes, yielding 1,737 gallons juice, weighing nine pounds per gallon, or 15,633 pounds, being four per cent. of sugar and 9.50 per cent. of molasses, or 13.50 per cent. together.

This sugar is of a yellowish brown color, about as dry as, and about the color of second quality Cuba sugar, such as is used by refiners. (See sample No. 2.)

THIRD EXPERIMENT.

Oct. 23. Temperature 8 A. M. 36°. M. 55°. Foggy. The foregoing favorable progress induced me to make another trial, on a larger scale. The weather looked threatening, and as a precaution, I cut five hundred feet of canes and stored it in the barn, to be used in quantities conforming to my means of working.

Nearly a month having elapsed since the first polariscopic observation was taken, and two weeks since the second practical experiment, having had several heavy white frosts, and three nights of ice, one eighth to three sixteenths of an inch in thickness, I con-

cluded to have another examination by polarized light, to see the the effect of these changes, when I was gratified to find the following results; juice weighing full 10° Beaume:

First observation, right	55°	
Add ten per cent. for dilution,	5°.5	60.5 right.
After inversion,	2°	
Add ten per cent. as above,	0°.2	temperature 25° 2°.2 left.
Sum of inversion,		62°.7

This sum of inversion, (62°.7,) at temperature 25°, indicated 79.06 grammes of sugar per litre of juice; then,

As 204.24 : 18.82 :: 79 06 : 7.29 per cent. of sugar in the juice.

		Feet.	Canes.	Galls. Juice.	
Oct. 24, Temp. 8 A. M. 51°, noon 60°. Fog and rain.	Ground	100	160	18¾	10° B
Oct. 26, Temp 50°—60°. Heavy rain.	"	100	159	18½	10° B
Oct. 27, Temp 46°—52°. Very stormy.	"	100	166	18 1-16	10° B
Oct. 28, Temp 40°—52°. Cloudy, N. W.	"	100	149	16¾	10° B
Oct. 29, Temp. 43°—48°. Clear. N E.	"	100	148	14⅞	10° B

These several parcels were clarified like the second experiment, boiled to 15° and 18° Beaume, and set aside till November 2d, when I found all but the last day's work had changed to a thick, liver-like mass, resembling good soft soap, very acid, and totally ruined. The last parcel, having stood a much shorter time than the rest, was but partially affected. It was boiled to proof and crystallized very well.

I regret this misfortune less for the trouble it cost me than for the failure of the experiment, for it worked beautifully in the first stages, and the last grinding crystallized freely. The juice weighed heavier than previous or subsequent parcels, and would probably have produced better results It taught me, however, the danger of delay, and also that no injury had been sustained by the juice so long as the canes remained unground, the last parcel having crystallized perfectly.

FOURTH EXPERIMENT.

Nov. 2. Temp. 38°—50°. N. E. clear. Since the 28th October, the weather has been mild and foggy, with heavy rains; temperature varying from 48° to 60°. A very decidedly increased development of sugar in the juice has been ascertained, viz.: 7.29 per cent., instead of five per cent., and I have gained some experience; so, instead of allowing the syrup to remain from four to twelve days, still containing a great portion of its fermentable impurities, gradually undergoing decomposition and depreciation, I remedy this evil to some extent, as will be seen. I also dispense with the fine ivory black and the filtering, thus simplifying the process.

Nov. 2. Temp. 38°—50°. N. E. clear. Cut and ground fifty-eight feet of a row, one hundred canes, the upper portions of the stalks turning yellow, leaves dead and dry; ground six and seven of the lower joints, produced ten gallons juice, weighing 10° Beaume, much less acid than previous samples, and barely changing litmus paper, neutralized with milk of lime, and clarified at once perfectly with eggs, passed it immediately through three and a half feet black, and boiled it to 234° Farenheit; after standing an hour the crystals were large and sharp, but not very abundant till morning, it being boiled too low.

Nov. 4. Temp. 31°—50°. Ice. Cut and ground fifty-eight feet, one hundred canes, nine and fifteen sixteenths gallons, 10° Beaume, rather more acid than the last, clarified it fully as above, passed it through five feet black, and set it aside, as it is clear and bright, and contains no feculent matter.

Nov. 5. Temp. 34°—62°. S. W. Cut and ground fifty-eight feet, ninety-four canes, nine and three quarter gallons, 10° Beaume, treated as above, and set it aside.

Nov. 6. Temp. 50°—62°. S. cloudy. Weather changing, cut and ground fifty-eight feet, ninety-five canes, nine and five eighths gallons, 10° Beaume, treated as above; also ground the tops of all the above 232 feet, which produced four gallons, two quarts, and three half pints of juice, weighing 12° Beaume, more acid than the lower joints, treated it the same, boiled it to 238° Fahrenheit, and set it aside. In the morning I found a good crop of crystals, but the mass thick and viscid, added three tablespoonsful clear lime

water, heated it to enable me to pour it into a mould; gross weight nine and a half pounds, tare four and half pounds, net five pounds. On the 13th knocked it out, and had three pounds good brown sugar, and two pounds molasses.

Nov. 7. Temp. 54°—66°. South. Boiled one half of the remainder of the proceeds of the above lower joints (one third of the whole having been boiled on the 2d as above stated) to 236° Fahrenheit, and added it to that boiled on the 2d; boiled the other half to 237° Fahrenheit potted it at 176° Fahrenheit, very handsomely crystallized, and very light colored.

Nov. 8. Temp. 60°—74°. S. W. Withdrew the stops and set it on pots to drain.

Nov. 9, Temp. 34°—50°. S. W. The full mould (fifteen pounds size) had run one and one eighth gallons molasses, or syrup; if it had been boiled a little higher it would have produced more sugar, and less molasses.

Nov. 14. Temp. 30°—42°. N E. ice. The whole having now stood seven days and being thoroughly drained, weighed as follows:

1 small mould, 10 lbs			
Tare, 4¼			
	net weight of sugar, 5¾ lbs.		
1 larger " 18¼			
Tare, 7			
	" "	11¼	
Sugar from the tops,		3	
Product of 232 feet canes,		19.75 lbs.	
1 pot molasses, 17 lbs., tare 5 lbs.			12 lbs. net.
1 " " 9 " 5			4
1 " " 12¼ " 5			7.25
Molasses from the tops,			2
Product of molasses from 232 feet canes,			25.25
236 feet are more than one fiftieth part of an acre by fourteen feet, therefore deduct pro rata, - - - - -		1.19	1.52
Product of one fiftieth part of an acre,		18.56	23.73
Multiply by - - - - - - -		50	50
Product of an acre in lbs - - -		928 00	1186.50
A gal. of molasses weighs 12 lbs, therefore divided by 12 for gals.			98.87

and we have 928 pounds sugar (first returns) and 98 87 gallons molasses, made from one acre (18,277) of canes, which produced 1847 gallons juice, weighing at nine pounds per gallon, 16,623

pounds, or, sugar, first crop, 5.58 per cent., molasses, 7.14 per cent., together, 12.72 per cent.*

This sugar is perfectly dry, as shown by Sample No. 4, it worked perfectly, and without the slightest difficulty, at every stage.

Nov. 17. Temp. 34°—48°. N. W. Boiled all the molasses from the above (except the two lbs. from the tops, which was too poor for recrystallization) 23.25 lbs. : added clear lime water until it marked 35° Beaume when boiling; took off a thick, glutinous scum, and boiled it down to 243° Fahrenheit. In two hours it produced a copious crop of very good crystals. Allowed it to stand till morning, when it was quite solid.

Dec. 18. Temp. 30°—52°. S. E. Here an unfortunate accident occurred. Having placed the crystallized mass over a slow fire, to render it fluid enough to cast into a mould, I was called off to a case of illness, leaving it over the fire, and being detained much longer than I anticipated, on returning I found all the grain melted and the molasses boiling vehemently, and badly burned. Much discouraged, I however proceeded. It crystallized the second time, and was put into a mould.

Dec. 20. Weighed the sugar from the 23.25 lbs. molasses boiled on the 17th November, as follows, viz.:

Gross weight,	11	lbs.
Tare,	4¾	
Second crop of crystals from the 23.25 lbs. molasses,	6 25	lbs.
Deduct pro rata for the 14 feet excess over one 50th of an acre,	.373	
Second returns from one fiftieth of an acre,	5.877	
Multiply by	50	
Product of an acre from the molasses,	293.85	

Then we have, as the whole final result of an acre of canes,

	Sugar.	Molasses.
1st returns,	928 lbs.	1186.50 lbs.
2d " (Sample IV.)	293.85	
And deduct molasses converted,		293.85
	1221.85	892 65
And 12 lbs. molasses per gallon gives		74.39 gal.

* Neither the scales in which this juice was weighed, nor the quart measure in which it was measured were sufficiently delicate or accurate to give precise results, and as they form the basis of these calculations, the per centages are probably not absolutely exact, but they are sufficiently so for all practical purposes.

Say sugar, per acre, 1221,85 lbs.; molasses, per acre, 74 39 gallons; sugar, per cent., 7.35;* molasses, per cent., 5.37; sugar and molasses, 12.72 per cent.

I will repeat here, that, owing to the accident before stated, this sugar, (Sample No. 4.,) 2d returns, is not nearly of so good quality as it otherwise would have been.

FIFTH EXPERIMENT.

Nov. 9. I must now mention that the last experiment was intended to have been on a considerably larger scale than those previous. Each day's work was, however, kept distinct and separate from the others, thus enabling me to determine it at any point.

Having thus proceeded to, and finished the clarification of the 4th parcel, (Nov. 8th,) and the weather becoming and continuing very warm, (thermometer as high as 74°,) I observed a very sudden and unfavorable change in the working of the juice. Instead of clarifying perfectly and with great facility, as at first, the defecation was difficult, the color many shades darker, and the juice gradually fell off in weight from full 10° Beaume to 9° Beaume, and required ten feet of granulated black to bring it to the same color as that made six days previously with five feet black. I however proceeded (keeping this separate) to the crystallization.

Boiled it to 242° Fahrenheit, when it produced good, hard, sharp crystals; but finding the quantity, by measurement, had decreased very considerably, I took no further note on that head, but gave it white liquor until it was neat, (about the usual quantity,) and produced the sugar, (Sample No. 5,) being white sugar, directly from the cane, without refining or re melting.

SIXTH EXPERIMENT.

Nov. 27. Since the canes for the fourth and most successful experiment were cut, on the 6th inst, the weather has been very changeable We have had warm Indian summer weather, with

* It may, perhaps, appear inconsistent to the casual observer, to find 7 35 per cent. of sugar obtained, when the juice only contained 7.39 per cent., as shown by the polariscope. This is readily explained. 1st, by the causes stated in a previous note; and 2d—the polariscope indicates pure sugar; whereas the sugar produced contains about four per cent. free moisture, and about three per cent. of molasses adhering to the crystals, also gum, &c., which would account for much more than the apparent excess.

heavy rains, also very cold weather, making ice two inches in thickness—thermometer having varied from 16° to 60 To try the effect of these changes, I cut one hundredth part of an acre, which produced 11 15-16ths gallons of juice only, instead of nineteen or twenty gallons, as before. It had, however, regained its former weight of full 10° Beaume, but was much more acid, rank, and dark colored than previously. It clarified without difficulty but raised a much thicker and denser scum, and when concentrated, was very dark and molasses-like; it however produced good, hard, sharp crystals, but the quantity being much reduced, there was no inducement to pursue it further. This experiment proves, however, that this cane will withstand very great vicissitudes of weather, without the entire destruction of its saccharine properties.

SEVENTH EXPERIMENT.

Took the proceeds of the experiments that were considered failures, viz., all the third and the poorest portion of the second, viz.: thirty-four pounds very indifferent sugar; refined it in the open kettle, by the old process, and produced fifteen pounds loaf sugar, (Sample No. 7,) which is a very full yield for the quality used.

The foregoing are all actual results produced by myself, (the polariscopic observations having been taken on the spot, under the supervision of my partner, Mr. William Morris Davis) with no object in view but the truth, and a desire to contribute whatever useful information I could towards the solution of this interesting and important question. They are, I think, sufficiently flattering in themselves to warrant renewed exertions on the part of our agriculturists of the Northern and Middle States especially, and perhaps those of the South also, in the pursuit of this promising branch of industry, to the full and profitable development of which it is certainly capable, and which it is destined ultimately to attain-(as before mentioned they have been accomplished without the advantages of the powerful sugar mill, the vacuum pan, and the many other improved implements and apparatus now in general use in Louisiana and elsewhere) and they are also very important and interesting in many respects, not apparent to those unacquainted with the subject; it may therefore not be superfluous to make some further explanatory remarks:

1st. The mill used and the power employed in these experiments were much less efficient than those in general use on sugar plantations, and the waste proportionally greater; the loss from which causes I estimate at not less than ten per cent.

2d. It is well known to all who are acquainted with sugar and saccharine solutions, that, by frequent heatings and coolings, a considerable portion of the crystallizable is converted into the uncrystallizable sugar, and is consequently lost as sugar. In these experiments every parcel was from necessity heated and re-heated from eight to twelve different times.

3d. It is impossible to produce as good results, whether as regards quantity or quality, from small as from large quantities.

4th. This sugar, (Sample No. 4.) is quite dry, and will lose comparatively nothing by drainage; the yield would be considerably greater, if it contained the usual quantity of footing that is contained in the hogshead when sold at the plantation, one of which being weighed there and re weighed in Philadelphia, in the month of July, will be found to have lost by drainage from 100 to 150 lbs., or from 10 to 15 per cent.

Assuming these propositions to be true, I make the following estimate of the probable yield of an acre of canes of ordinary growth, such as I have experimented upon, viz.:

Actual yield as per Experiment No. 4,		1221.85 lbs. sugar, 74.39 molasses.
Add for inefficiency of mill,	10 per cent	
For heating and re-heating, &c.	5	
For footings, say but*	5	
	20 per cent.	244.37
Probable yield per acre,		lbs. 1466.22 sugar: gall. 74.39 molasses.

Further, it will be observed that my acre produced but 1847 galluns of juice. I have, however seen published accounts of far greater yield than this; one, for instance, in this country, apparently well authenticated, reaching 6,800 gallons per acre, which, according to my *actual* results, would produce 4499 lbs. of sugar, and 274 gallons molasses—and according to the foregoing *probable* results, would yield 5389 lbs. sugar, and 274 gallons to the acre. I

* These two latter gains in sugar would be made at the expense of the molasses, taking from it the gain which would be realized by the use of a better mill, and therefore leaving the quantity of molasses unchanged.

do not pronounce such a yield of juice impossible, but it will certainly be of rare occurrence—a mean between this and my yield would be a large return,

Another subject worthy of notice is the nature of the season. My impression is, that owing to the lateness and coldness of the spring, and the continued wet weather, the last has been quite an unfavorable season for the ripening and development of the sugar in the juice, to which cause I think a deficiency in the yield of at least ten per cent. may be attributed, which would further increase the quantity to 1612 lbs. of sugar, and 81 8-10 gallon molasses, a yield very nearly corresponding with that of the best conducted plantations of Louisiana, as will be seen by the following figures, which I have collated from a minute statement furnished to me by the enterprising proprietor of one of the most complete and costly establishments in that region (it being furnished with vacuum pans, and all the most approved machinery of later times, and conducted under his own personal supervision,) of the actual product of one of his plantations of 266 acres, for eight consecutive years. These figures will also furnish useful data for the estimation of the cost of production here, viz.:

Aggregate yield of juice from 266 acres for eight consecutive years, - - - - - -	4,757.700 gallons.
Aggregate yield of sugar, - - - - -	3,626,425 lbs.
" " molasses,- - - - -	217,585 gallons.

COMPARISON.

LOUISIANA.	PENNSYLVANIA.
Yield of juice per acre,..... 2,236 gals.	.....1,847 gals.
Density of juice, (Beaume) 8 44°	.....10°
Yield of sugar per gall. of juice, ... 0 76 lbs	.....0.66 lbs.
Yield of sugar per acre,.....1,704 "	Actual .....1,221.85 lbs. Probable 1,612.00
Yield of molasses per acre, ..102 gals	Actual .....74.39 gal. Probable.....81.83
Wood consumed per acre, 3 87 cords, at $2 50 per cord.	
Coal for engine, 0.41 tons at $2 50 per ton.	
Labor, per acre, 3.70 days.	

These details have been extended to a much greater length than was at first intended, but perhaps not beyond a useful limit for those interested. To the working farmer they may appear formidable and prolix; but he may, nevertheless, gain some grains of useful knowledge from them to repay for their perusal. The conclusions to be drawn from them will be seen by the following

SYNOPSIS.

1st. That it is obvious that there is a culminating point in the development of the sugar in the cane, which is the best time for sugar making. This point or season I consider to be, when most if not all the seeds are ripe, and after several frosts; say when the temperature falls to 25° or 30° Fahrenheit.

2d. That frost, or even hard freezing, does not injure the juice nor the sugar, but that warm Indian summer weather, after the frost and hard freezing, does injure them very materially, and reduces both quantity and quality.

3d. That if the cane is cut and housed, or shocked in the field when in its most favorable condition, it will probably keep unchanged for a long time.

4th. That when the juice is obtained, the process should proceed continuously and without delay.

5th. That the clarification should be as perfect as possible by the time the density reaches 15° Beaume, the syrup having the appearance of good brandy.

6th. That although eggs were used in these small experiments, on account of their convenience, bullock's blood, if to be had, is equally good, and the milk of lime alone will answer the purpose; in the latter case, however, more constant and prolonged skimming will be required to produce a perfect clarification, which is highly important.

7th. That the concentration, or boiling down, after clarification, should be as rapid as possible without scorching, shallow evaporators being the best.

INSTRUCTIONS *for the Domestic Manufacture of Sugar and Syrup, upon a small scale, from the Juice of the Sorgho, being a Practical Application of* J. S LOVERING'S *Process.*

For the use of persons unacquainted with the subject, we commence with a brief statement of

GENERAL PRINCIPLES.

The juice of the ripe Sorgho is composed of

1. Crystallizable sugar, about seven and a quarter per cent.
2. Uncrysallizable molasses, about seven per cent.
3. Acid.
4. Vegetable mucilage, or gum.
5. Coloring matter.
6. Water.

Our object is to separate the sugar and molasses.

The acid and mucilage prevent the sugar from crystallizing.

1. Our first step will be to neutralize the acid in the juice by combining it with an alkali (lime).

2. Our second step will be remove the mucilage by the addition of liquid albumen (blood, eggs, or milk) to the cold juice; we then apply heat; the albumen, being heated, coagulates, and, rising in the form of scum, carries the mucilage with it. This process is called *clarifyiug*, and should be *twice* repeated at least.

3. Having now got rid of the acid and most of the mucilage, our third step is to remove the *coloring matter*, by filtering the clarified juice through granulated bone black.

But a *peculiar mucilage* still remains, inseparable at a lower heat than about 225° Fahrenheit.

4. Our next step will be to boil the filtered juice to 225° Fahrenheit, and then to add lime water This mucilage then rises as a scum, and is removed.

We have now left a solution composed of 1. Sugar. 2. Molasses. 3. Water.

5. To crystallize the sugar, we must evaporate the excess of water, by boiling. Most of the sugar will crystallize when the solution grows cold. The unchrystallized part, we drain off as molasses.

These operations require the greatest exactness, for

If we do not boil enough, the sugar contained in the solution will not crystallize when cold; or,

If we boil too much, the molasses will become so thick when it cools, as to impair the crystallizing of the sugar, and cannot be separated from it.

But how shall we know when to stop the boiling?

By the heat of the boiling liquid, as marked by the thermometer.

Pure water boils at 212° Fahrenheit's thermometer. You cannot make it hotter without changing it to *steam*.

The Sorgho juice, being a solution of about fourteen per cent. of sugar and molasses, &c., in water, becomes three degrees hotter before boiling, and boils at 215° Fahrenheit. As the water evaporates, a greater heat is required to keep the concentrated juice at a boil; in other words, the juice grows hotter and hotter. When it reaches the heat marked on the thermometer 238° Fahrenheit, there is just enough water left to enable the sugar to separate from the molasses when cold.

6. We now pour the concentrated juice into a mould, a keg, a barrel, or other deep vessel, with a plug in the bottom, and allow it cool.

7. When quite cold (say twenty-four hours), we remove the plug. The liquid portion, being molasses with a little sugar and water, gradually drains out, leaving the sugar dry in from four to ten days.

It is also important to remember

That the juice begins to ferment almost as soon as it leaves the cane, and therefore, should be neutralized, clarified, and boiled *without delay* A very few hours' delay will spoil it.

A long continued exposure to heat gradually converts crystallizable sugar into uncrystallizable molasses, therefore, the evaporation should be *as rapid as possible*.

A concentrated solution of sugar and molasses is very liable to burn, and should, therefore, be carefully watched, and exposed to a *more and more moderate fire* as the evaporation advances.

The use of a saccharometer is to indicate the relative weight or density of a liquid as compared with water. This density depends upon the amount of sugar, or other heavy substances held in solution. Consequently, the degree of density indicated by the saccha-

rometer is an index of the proportion of sugar, &c., contained in the juice.

It is simply a hollow tube terminating in a bulb, loaded with shot, to keep the bulb down and the tube upright Floating in pure water the tube, at the point where it appears above the surface, marks o. But in proportion as the liquid is heavier, the bulb does not sink so deep, and more of the tube appears above the surface. The density of the sorgho juice, cold, is about 10° Beaume, so called from Beaume, the inventor.

If your kettles or moulds are of iron, give them two good coats of white paint *inside*, drying each coat thoroughly. This prevents the sugar from being made dark by contact with iron, which will be the case if the slightest acid be present. Before using them, scald them thoroughly *twice*, letting boiling water stand in them until cold, to remove the taste of the paint.

In George R. Porter's work on Sugar-cane, on pages 147 to 150, we find the following, that will be found useful to many:

"The proportion of essential salt which the cane liquor contains can not, by any means, be augmented; the sweet and saccharine mucous juices can not be converted into sugar; nor can the former and the mucilage be removed before the complete concentration of the syrup, since those juices are more soluble than the essential salt.* The end proposed, then, is to extract the greatest possible quantity of this salt in the best posible state. For this purpose we must borrow the aid of chemistry, the principles of which are much more required in the concentration and crystallization of middling and bad syrup, than in that of good quality. *The sweet and saccharine mucous juices can not support nearly as high degrees of heat as the essential salt.* They are immediately decomposed by the ap-

* Some of my readers may not understand that this term, "essential salt," in this connection, means the sugar.—HEDGES.

plication of degrees of heat which may safely be used to syrup of good quality. The business of concentration, as we have before observed, is the action of heat upon the water of solution of the sugar. The sugar-boilers, both of America and Europe, have rarely had a just conception of the action of heat in the operation of concentration.

"Concentration, being the action of heat upon the water of solution, ought necessarily to begin and terminate at fixed degreees of the thermometer. The truth of this position Dutrone affirms to have been demonstrated to him by multiplied experiments made with solutions of sugar refined to a state of perfect purity, and to which he applied the action of heat at each degree, commencing at 219°, and ending at 279.5° of Fahr.

"Each of the experiments was made with a solution of one hundred pounds of sugar in sixty pounds of water. When the degree of heat, indicated by the thermometer, is ascertained, a reference to this table will show, at one glance, what proportion of the water of solution has been evaporated, what quantity of sugar is thereby rendered capable of passing to the solid state, and how much water is yet to be evaporated before the remainder of the sugar can be crystallized. If, for example, during the process of concentration, the thermometer rises to 230° Fahrenheit, this table informs us that 31 lbs. 3 oz. 4 dr. of water have been evaporated, that fifty-two pounds of sugar have thereby been rendered capable of crystallizing, and that 28 lbs. 12 oz. 12 dr. of water remain to be evaporated, before the remainder of the sugar, forty eight pounds, can assume the solid form.

TABLE.

Of the action of heat upon a saturated solution of sugar, commencing at the point of saturation, and terminating at the point of perfect crystallization.

Degrees of thermometer	Water of solution evaporated at each degree.			Product of crystallized sugar at each degree.			Water which remains combined to the sugar in the state of syrup after the crystallization, at each degree.			Sugar which remains combined with the water in the state of syrup at each degree.		
Fahren	lbs.	oz	dr.	lbs.	oz	dr.	lbs.	oz	dr.	lbs.	oz.	dr.
219	0			0			60			100		
221	4	12	14	8			55	3	2	92		
223	11	8	14	19	4		48	7	2	80	12	
225.5	18			30			42			70		
228	24	9	10	41			35	6	6	59		
230	31	3	4	52			28	12	12	48		
232	33	11	10	56			26	4	6	44		
234 5	36	3		60	5		23	13		39	11	
237	38	1		63	4		21	15		36	12	
239	39	4		66	3		20	12		33	13	
241	41	7	10	69	2		18	8	6	30	14	
243.5	43	4		72	1		16	12		27	15	
246	45			75			15			25		
248	46	7	4	77	7		13	8	12	22	9	
250	48	7	8	80	5		11	8	8	19	11	
252.5	50	1	10	83	3		9	14	6	16	13	
255	51			85			9			15		
257	52	5	14	87	4		7	10	2	12	12	
259	53	1	6	88	6		6	14	10	11	10	
261.5	54	1		90	1		5	15		9	15	
264	55	3	10	91	4		4	12	6	8	12	
266	55	12		92	7		4	4		7	9	
268	56	7	10	94	2		3	8	6	5	14	
270 5	57	3	8	95	5		2	12	8	4	11	
273	58	6	8	97			1	9	8	3		
275	58	14	8	98	2		1	1	8	1	14	
277	59	7	10	99	2			8	6		14	
279.5	60			100								

"Although soluble matters, other than the essential salt, are combined with the water of solution, the water is, nevertheless, always united with it in a relative and determinate proportion. The thermometer ought, therefore, to be employed to determine its concentra-

tion, the solid product having always relation to the proportion of water which the heat has evaporated at at each degree of this instrument. If the extraneous matters exist in a greater abundance, the quantity of pure sugar will be less than that marked in the foregoing table."

I have already remarked that the process of sugar making is quite simple, and as an evidence of this assertion, and for the encouragement of others, I will here give the process (if such it may be called) employed by Mrs. Hooker, of Schuyler county, Illinois, whose success was fully reported by the press of the country in 1863. Being desirous of examining the cane, in order to satisfy myself of its variety, as well as to have the particulars of cultivation and manufacture, I visited the farm and obtained the following facts in relation thereto: The apparatus consisted of a two-roll, wooden mill, a tub to receive the juice, and an evaporator, made as follows: a sheet of iron, two feet wide and some eight feet long, with about one foot of each end turned up, forming the ends, while two planks, one-and-a-half inches thick, formed the sides; to these the iron was thoroughly nailed. This, set upon a rudely-constructed furnace, constituted the train. The process consisted in introducing twenty-seven gallons of juice as one charge, adding to this, when slightly warm, one tablespoonful of soda; sometimes eggs and milk were added, but not all the time. As the scum rose, it was carefully removed, and, when this was reduced to a tolerable syrup, another tub of fresh juice was added, and the same treatment repeated as before; and, in like manner, when this had become reduced, as before, a third installment of juice was added, with a continuance of

the former treatment. This now constituted a full batch, and as soon as reduced to the degree that her experience, in making sugar from the sap of the sugar tree, had indicated as a suitable degree of concentration, the batch was removed from the fire and set away, in a tub, to granulate, which granulation proceeded directly, the sugar being fair in color, and in good hard crystals.

At the time I visited them, December 18th, there remained yet on hand some of the last boiling, after the cane had been frozen; nevertheless, a fair per cent. of crystallization had resulted. The quality of the molasses that had drained from the sugar was quite as fair in color and rich in flavor as the syrup of the best works in the country. There was, evidently, a large per cent. of the sugar yet remaining uncrystallized. There were, probably, several causes for a lack of a full success in crystallization; the use of soda, instead of lime, and by far too little of it, as the molasses was quite tart; the want of a warm place to facilitate granulation, and, in all probability, not reduced quite as much as required for the best results, had all the other conditions been obtained; these circumstances, when all considered, make the success, as it was, still more encouraging. There is much due to the variety of cane used, because there have been numberless similar operations with the Chinese and some othes varieties of the Imphee, without equally favorable results.

The molasses, drained from the sugar referred to above, was of a quality to recommend this cane as productive of a good article of syrup, as well as sugar, although it is not desirable to have syrup, made for

use as such, to granulate on the hands of the consumer.

The subjoined communication, from our worthy fellow-citizen and patent agent, Mr. Samuel Knight, will be found of interest, showing that sugar from corn stalks has attracted attention before. I had a recollection of the reports, and had a conversation once with our old commissioner of patents, H. L. Elsworth, upon the subject, many years ago. This, like the other canes, has to be carefully studied by the farmer as well as the sugar expert. That there should be less difficulty in crystalizing the juices of the corn canes than any of others, is to me clear, as the joints of the corn stalk has no vegetable gum that is nucleus, or germ of a new cane. It is well known that if you cut off the seed tuft before cutting up the cane, a new stalk shoots up from the joints below, showing that there is still vegetative force left, and each joint is the focus of its out-growth. But not so of the corn stalk, no new stalk ever grows from the joints. Now, if this gummy joint changes by being cut up and allowed to mature as well as the acid in the juice, we may profit by such treatment. The juice of the stalk between the joints will crystalize very readily when boiled rightly. Hence, light pressed cane, in like manner, will more freely granulate. The granulation of so many samples of sugar in the acid syrup causes me to reflect much upon that fact, and leads me to infer that it may not be the acid itself so much an obstacle as other conditions or properties in the juices. The syrups of Mr. Kenney's make are very bright and free from fecula of any kind. His cane was hardly matured when cut, but rested a month or more with foliage on, which is a significant fact, and agrees with many

other reports, as well as my own experience. In this respect these canes resemble the Southern canes *saccharum officinarium*. These facts and reflections open a large field for investigation.

ST. LOUIS, MO., March 31st, 1879.

"I. A. HEDGES, ESQ.—Dear Sir—At your request I have examined the Patent Office reports (Agricultural), as far as I was able, in reference to the production of syrup and sugar from common corn, about the year 1840.

"In the Agricultural report for 1842 may be found accounts of a number of experiments made that year in the production of molases and sugar from the stalks of ordinary field corn.

"The results were generally considered encouraging, as proving the value of common corn as a sugar producing plant.

"Molasses of prime quality was made; but the success was much less marked in the production of sugar; for while some found crystallization to take place readily, others had to report partial or total failure in this respect.

"Among the reported experiments may be instanced the following:

"Mr. Webb, of Wilmington, Del., seems to have been the first person to introduce the matter to extended public notice, and to demonstrate its practicability by experiment. He *sowed* corn and let it fully ripen before pressing the juice from the stalks. Most of the sugar was obtained from 'frost killed corn.' He reports the molasses of superior quality; and as crystallizing readily when sufficiently boiled down.

"Mr. Blake, of Indianapolis, Ind., tried to get

sugar, but failed. His corn was grown in *drills* four feet apart. Four and a half acres produced 275 gallons of thick molasses. Twenty-five gallons of expressed juice produced four gallons of molasses. He estimated that one-third of the juice was left in the stalks. His machinery was far from perfect. With the use of two horses, worked alternately, he 'ground out' 300 gallons of juice in eighteen hours.

"The cost of production was from $12 to $15 per acre, a great part of the labor consisting in stripping the blades from the stalks.

"The conclusion was reached by some that large stalks yielded more sugar than small ones; and consequently that the corn should be planted in hills or drills, and not sown broadcast.

"Other experiments were reported at this time (1842-3). An opinion was prevalent that field corn would supersede the maple as a sugar producer. From 600 to 1,000 pounds per acre was the expected product.

"It is scarcely necessary to say that time has not borne out the above sanguine expectations. Various causes may have conduced to this failure without in any way affecting the main issue. Among these may be mentioned, first, the want of proper machinery and apparatus; second, ignorance in reference to the treatment of the juice and syrup, and, third, the interference with ordinary farm work by the introduction of a new industry. Yours respectfully,

"SAMUEL KNIGHT."

CHAPTER XI.

SYRUP MAKING AS A BUSINESS.

Inasmuch as a large proportion of the cane grown must continue to be worked up into syrup, it is important to consider the best methods for producing a good article, and one that will stand the changes of the seasons. Out of some thirty samples of syrup sent to the late convention, fully one-half are of a quality that would not endure the hot weather without fermentation, which would render them still more unpalatable. It may be quite as well to leave the free acid in all such syrup as is intended for winter use or baking purposes, especially for those who have become accustomed to its flavor and do not, therefore, object to it. But for summer use and to sell in cities to those not so habituated, the system employed by Mr. Schwarz, whose syrup is so well liked by all who use it, that it will be found essential to adopt his plan of treating it, or some plan equivalent to it, which, however, is the same as employed by myself, eighteen years since, when a sample of twenty gallons being sent to President Lincoln, I was immediately requested to furnish a paper for the reports of 1861.

A city market cannot be found to equal the country until the quality is thoroughly improved, which can only be done by the means indicated. When syrup is used for curing meat, the acid should be fully neutralized, as it is the saccharine that is needed for preserving, hence any acid, therefore, would be detrimental. The free use in this way will be found more palatable and healthy than so much salt. Our large pork packers would use it in curing hams could they get it of the quality and quantity required at all times. But I repeat that the city cannot be relied upon for a market until a general system of manufacture shall result in producing a uniform good article of standard grades, by which a dealer can at all times replace his stock with a duplicate grade to suit his customers. Then it must be so made that it will neither ferment or granulate upon his hands, by which his profits will be lost. Therefore, it will become important to have a test of the cane juice before commencing to work, in order to know whether it possesses enough crystallzable cane sugar to justify boiling it to the sugar degree. It is to this end, as one feature, that cane-growers' association should be formed for conjoint efforts to disseminate knowledge,

It is highly important to be able to determine, not only what variety of cane will make sugar, but at what stage of development it should be worked, as boiling it down to the requisite degree for sugar is rendering it not suited for syrup, and again it is essential to know how much cane-sugar is present in the juice in order to know whether it will pay to make sugar, or to inspissate it to the syrup standard only. To determine this calls for the polariscopic test. This, however, cannot be made generally applicable, as the expense

of such instruments and the services of a competent expert will not justify the outlay. But should the business finally become as extensive as the indications seem to warrant a hope, by which large works are established, then such expense will be justified. Another plan presents itself to my mind, viz.: In the organization of associations, embracing considerable district of country, let there be some competent person elected as secretary and expert, who, being provided with the requisite apparatus, can have representative specimens of cane sent by mail during the maturing period of the canes, which can be tested at small expense, and report returned by next mail, thus affording a reliable data by which to be governed. Such an arrangement may save many mistakes, and place this business upon a scientific basis, and insure thereby a speedy advancement. Some such movement is a necessity. There is too much importance attached to this industry to be allowed to struggle on at random like a ship at sea without a pilot. It has been from these considerations that I have effected the establishment of a series of cane stations and correspondents in nearly every State and Territory west of the Alleghany Mountains, who are to cultivate the Early Amber cane, and report to me with samples, as above indicated. The first will probably reach me by early in June from the south of Texas, next from Louisiana, and so on, closing with Oregon, Idaho, and Minnesota, Arizona, etc. I have taken upon myself a considerable task, but with such assistance as I have offered me, and a liberal patronage of those interested, I shall carry it through.

There a is constant enquiry about what to do with mush sugar in the country, as it is unsalable in that

condition. Now the first thing to be done is to determine whether it is cane-sugar of hard, sharp crystal, or soft grape sugar. If of the former and enough of it, swing it in a centrifugal; if of the latter, reheat it, adding about one gallon of water to eight of mush sugar, and boil it actively to 228° B., and you will have renewed, fine syrup. If it proves to be tart, there may be some lime added to the water before stirring it into the syrup. For method of doing this see chapter on Defecating and Neutralizing, etc. I can send litmus by mail should it be difficult to procure it in the country, eight or ten postage stamps worth being ample supply.

I have had a few samples of syrup and molasses polarized, Mr. Schwarz's Early Amber being 39.5; Mr. Leonard's, of High Hill, Mo., Honduras cane, 40.°

I learn by a conversation with Mr. Belcher that in the *Polariscopic* tests that it is not so much a test between sugars of different latitudes and countries, as between those of the same varieties and latitudes; therefore, allowance has to be made in this respect. Some further experience in these Northern canes is necessary to give us a full knowledge of their true peculiarities and merits.

CHAPTER XII.

PRODUCTS, MARKETS, AND PROFITS.

Having considered the various departments of this cane culture and its manufacture, I now propose to devote a few pages to the subject as indicated above, for it becomes as interesting, to those engaged in the business, as any other feature of the enterprise. That there will soon be a surplus product, in the agricultural districts, is not only very certain, but much to be desired, as the commercial transactions are to be based upon the surplus of the country productions. Thus far the cultivation has been confined to mere experimental patches, with, here and there, an exception. Nevertheless, the aggregate number of gallons produced in the free States the past season, may be stated at thirty millions, and this will, undoubtedly, be doubled the coming season. Should it be quadrupled, it will not surprise me, and still it will fall short of a full supply; the consumption of foreign molasses, as shown by the letter of Mr. Belcher, has been fifty million gallons yearly. I say foriegn, as, in this connection, we may consider Louisiana molasses foreign.

There are, within my own knowledge, families that formerly used only ten gallons of New Orleans (sugar-house syrups included,) that are now consuming annually from fifty to sixty gallons of the Sorghum. This consumption will be increased, as experience suggests other uses, and as the rising generation come forward, who are everywhere more fond of it than adults; hence it is taking the place of fat meat to a very considerable extent. In curing meat, also, it will be extensively used when the price is such as to admit of its free use.

There could be ample testimony adduced to prove that its abundant use is conducive to health; being indigenous, it will attach itself to our appetites, and can not be supplanted by a foreign product, especially one of the tropics. Already our children, accustomed to the use of the Sorghum, will reject the finest specimen of Southern molasses, not from prejudice, but from choice of quality. From these considerations we may conclude that its use will continue so long as our soil and climate will produce it.

The following letter from Mr. Hunter will be found of interest, as showing how much value there is in the forage part of this crop. I could add any number of similar reports had I room, but will simply urge my readers to try it for themselves:

"MR. ISAAC A. HEDGES: Dear Sir—In reply to your inquires in regard to my experience and observation in relation to the value of the Sorgho crop, besides that of syrup and sugar making: My first crop was in the year 1857, and I have increased the cultivation annually, using the fodder every year, and I can say that I know it to be superior to corn or any other class of forage. I have only fed the seed for

the past three seasons. I fattened twenty-two hogs upon the seed, ground like chop feed, sometimes merely wet up, and sometimes scalded, sometimes allowing it to sour, and I think my hogs liked it best when sour. I consider it worth rather more than half as much as hard corn for hog-feed. I have fattened three head of beef cattle, and am now fattening the fourth, and am boiling the seed instead of grinding, using my sugar-pan for that purpose, and believe it a better plan than grinding the seed; I find cattle also to feed well upon it, and fatten fast. I have never had either to cloy or reject it. I am now feeding my milch cows upon the boiled seed, and they increased their milk considerably; besides, the milk is fully equal to any other feed. I have cut young cane, and fed it to my milch cows, and can say that it is unequaled for producing both quantity and quality; the butter, from such milk, is more yellow, if possible, than clover. I found, when feeding upon the leaves, stripped from the cane and dried, even in the winter, the butter was as yellow as when fed upon fresh clover.

"Very truly yours, C. W. HUNTER."

The syrup is being used for making printers' rollers, and found to answer an admirable purpose. The inferior syrups, made from scum deposits or sour cane, will find a market in all large cities for blacking making, and in the manufacture of the extract of coffee, for which purposes not less than three thousand barrels are used annually in this city. But, for these uses, it should be boiled very heavy, say 38° B., when hot, or 30° F.

In order to give our country friends an idea of the consumption of this city, I have arranged a condensed table from the annual statement of the Chamber of

Commerce of Cincinnati, in 1863. This table shows the aggregate imports of molasses for the last seventeen years; also the aggregate exports, with the balance, constituting the consumption of the city for the whole period, and also the annual consumption:

	IMPORTS. Bbls.	EXPORTS. Bbls.
Aggregate imports for the last seventeen years, ending August 31, 1862	1,126,712	644,415
Excess of imports over exports, consti uting the aggregate city consumption for the last seventeen years, of		482,297
Average consumption per annum		28,370

For the five years, 1856 and 1860 inclusive, the annual average is still greater, being 31,459 barrels. About four barrels per acre being the average yield of Sorghum syrup, it will require 7,864 acres to supply the annual consumption of Cincinnati alone. The average annual consumption of sugar, for the same period of five years, was 17,079 hogsheads.

Mr. J. M. Mohler, of Covington, Miami county, Ohio, gives me, as the actual cost of making his syrup, at sixteen cents per gallon, allowing for the forage of the crop, which foots up as follows:

One acre's product, 150 gallons, at 16 cents per gallon	$24 00
The use of land	5 00
Interest on outfit, costing $150	9 00
Total	$38 00
Proceeds of syrup, at 47 cents per gallon	70 00
Leaving a net profit, per acre, of	32 00

The following estimate is reported to me from Shelby county, and although the method of estimating differs, the results are nearly the same:

"REPORT.

Preparation of soil for planting	$2 00
Planting of seed	1 00
Working through twice with one-horse cultivator	2 00
Working through twice with one-horse plow	2 00
Hoeing and thining four times	4 00
Stripping blades, one hand, four days	4 00
Topping cane, one-and a-half days	1 50
Cutting and hauling cane to mill, one hand and team, three days	6 00
Use of land	5 00
Total expense	$27 50

"Now I will give you the products of the same acre. You can use it as you like:

173 gallons, at 50 cents per gallon	$86 50
The syrup was boiled to 40° Baume's saccharometer.	
Value of f. rage	5 00
Total profits	$91 50
Then deduct the price of making 173 gallons at 20 cents per gallon	$34 60
And the expense of cultivation and use of land	27 50
Total expense	$62 10—62 10
Total profit	$29 40

"I respectfully submit the above for your inspection. WILLIAM SHINN."

By the above it will be perceived that, although high wages are allowed, and very liberal pay for the use of land, and more time given for cultivation than required by expert hands, yet the net profit is $29.40, while a crop of corn, of fifty bushels per acre, at forty cents per bushel, would amount to only about two-thirds the sum, without paying its cost at all. The above are the estimates of manufacturing upon a small scale of only sixty or eighty gallons per day.

As the ultimate success of this crop will depend upon the low price at which it can be produced, I will here give an estimate of the expense, per gallon, for manufacturing upon a larger scale, using steam power for grinding, and fire and steam combined, for boiling, making at the rate of fifty gallons per hour:

MARKETS AND PROFITS.

Eight men, at $1.50 per day	$12 00
One superintendent, $3	3 00
25 bushels coal, at 10 cents	2 50
Interest on $5,000 capital, 8 per cent	7 65
Wear and tear	2 00
	$27 15
Cost of 2½ acres of cane at the mill, at $10 per acre	$25 00
Making no allowance for forage, toral cost	$52 15

CONTRA.

500 gallons of syrup, making 7 lbs sugar per gallon, or 3 500 lbs., at 5 cents	$175 00	
160 gallons molasses, 11 lbs. per gallon, at 25 cents	40 00	
		$215 00
		52 15
		$162 85

Making $64 net, per acre, or $162.85 per day.

Now, if the works are enlarged to double the above capacity the cost will not exceed 20 per cent. increase, and running expenses not to exceed the same rate. Hence the results would foot up still more favorable.

I have made no allowance for packages which will probably offset the value of the forage, leaving the figures as stated.

Should the works be run day and night, a saving of the interest item would be affected.

I do not offer these figures and footings for the purpose of exciting undue speculative or extravagant outlay of money, but in order to stimulate investigation, and thus qualify ourselves for the ultimate outcome of this business.

The very able letters and consistent suggestions of our friend Dougherty, are as finger-boards to the traveler, pointing out the way.

Cost of making 200 gallons of syrup per day, by two-horse mill, and a corresponding set of evaporators, estimating cost of works at $2,000, with interest at 8 per cent. per annum, for sixty days, per day	$ 2 25
Four men at $1 50	6 00
Two horses, $1	1 00
Two cords of wood, $2, or its equivalent	4 00
Wear and tear	1 00
Cane, per acre	10 00
Total cost	$24 25
200 gallons syrup, giving 1,400 lbs. sugar, at 15 cents	$70 00
100 gallons molasses, at 25 cents	25 00
	$95 00
	24 25
Net profit, per acre	$70 75
Now, if we fail to make sugar, and have only syrup, the result would stand, 200 gallons, at 25 cents	$50 00
Cost of production	24 25
Net profit	$25 75

In this we allow forage to be worth the cost of packages, barrels, etc.

I add here also Mr. Schwarz's reply to my enquiry upon the most important feature of this industry, viz.: the pay part. It will be seen that if we add to his figures my allowance for cost of one acre of cane, $10, it will just show the same result, and may, there-

fore, be considered a reliable basis for calculation. But, of course, it must be understood that we calculate upon good fixtures and active work, with cane of good quality. Persons must not expect these results and not comply with the conditions for obtaining it.

But should the seed be in demand for planting, with anything like the present rates, the profits would be greatly enhanced.

"EDWARDSVILLE, ILL., March 31, 1879.

"FRIEND HEDGES: I am just able to write a little to-day, so I send you my figures; what it would cost me to make two hundred gallons of syrup a day. The mill must be a heavy, strong four-horse one, with sweep below, of course.

Two men at the mill and two teams, board included, per day	$ 5 00
One man or smart boy at heater, per day	1 00
One man, expert, at evaporator, per day	3 00
One cord wood and twenty bushels of coal, or the equivalent in wood, per day	3 00
Lime-refining material, chemicals, and other incidentals, about	2 00
	$14 00

Being seven cents per gallon. You will see that an establishment making only one hundred gallons per day, has very near the same outlay—fuel is cheap here, wood $2.00 per cord, and coal five cents per bushel; of course, these are only running expenses—barrels for syrup are not included.

"In case of sugar, I could not make a good estimate, but inspissation would reduce the two hundred gallons to about one hundred and eighty gallons, which should make, with proper working, with the Early Amber, fifteen hundred pounds of sugar, adding an extra hand work the centrifugal, etc. You can readily see what

the expense will be—that is expected to be—for we cannot safely figure on sugar yet until another year.

"Yours, truly,

"C. M. SCHWARZ."

Bagasse burning, in combination with the wood above, would generate ample steam. This is predicted upon a thoroughly well-constructed establishment, with all the improvements for labor-saving. There is yet a large offal that may be turned to account, viz.: the scum, for vinegar or stock feeding.

The cost of cane, delivered at the mill, will be greatly reduced as our farmers become more familiar and expert in the cultivation and handling of the crop. When due credit is given for the seed and other forage of the crop, the cane can be delivered, at the mill, at $10.00 per acre, yielding two hundred gallons of syrup, thus increasing the cost of the syrup five cents per gallon; to this must be added two and a-half cents per gallon for casks, making a total cost of syrup, at the works, nine and eight-tenths cents per gallon. When we shall have availed ourselves of all the advantages that are sure to result from an application of the mighty mind of the American people, drawn out, as they are being, by the certain prospects of this very valuable product, then it will be that our market reports will announce the prices of the various grades of sugar, syrups, and molasses, the products of these Northern canes as a crop.

CHAPTER XIII

SINCE publishing my previous edition, there have been two crops of cane grown and manufactured, the results of which have added some valuable facts and discoveries that call for record and embellishment in connection with a practical work like the sugar canes.

It will be observed by reference to page 2, I have referred to and illustrated two tufts of cane, one that appeared to me possessing some evidences of excellence. I have carefully pursued the investigation by having it planted and replanted in different soils and latitudes and by as many different cultivators. The result has been highly gratifying, as will be seen by the many reports received, some of which are here inserted. In many sections of the country the season was quite severe for all varieties of cane, and thus the "Orange" suffered with the rest, but late rains assisted to make a fair crop. That it is a good sugar-producing cane, is well established, wherever the conditions favored its full development. The short period of its growth in Rusk county, Texas, is most remarkable, when taken in connection with the abundance of large, hard crystals formed in the syrup. The letter of Mr. Richards, of Fayette county, same State, gives another flattering evi-

dence of a superior quality in this cane, which, if finally sustained, will add greatly to its value. It may be protected from frost by throwing a furrow right and left over the stumps late in the Fall.*

The above is the only new feature of progress in the development of new varieties that has come to my notice. My confidence in the Honduras (so called) has been diminished, at least as a sugar plant. I have tests being made by some reliable planters to produce an hybrid of Amber, Orange and Honduras, which, if successful, may afford us a still more profitable variety. Such experiments, however, require several seasons to complete.

CUTTING AND HANDLING CANE.

IN this department it seems to be well settled that cane should be cut and worked as soon as possible after the seed has passed the dough state; that it does not pay to strip the leaves when there is sufficient mill capacity to press it with them attached; that it is desirable to have the cane rest long enough to let the leaves and husk on the stalk become cured before working or storing in heaps; that standing in shocks like corn is

* It is a well-settled fact in the reproduction of most crops that in transplanting from Southern to Northern latitudes, the same varieties will mature earlier, and also be of a correspondingly less volume of growth. This is particularly observable with these canes. Therefore we may expect that this variety will soon become as common in the extreme Northern States as the Early Amber, provided its saccharine richness and hardy qualities shall migrate with it. The firm shell of the stalk, as referred to by one of my Texas cultivators, has not only the effect to protect it from the excessive sun's rays, but gives it a much more vigorous stalk, hence it has hardly ever been known to fall before the wind. This firmness in the stalk will call for thorough milling, which will be compensated for in the better quality of the feed in the bagasse. Past experience has proven that it will not be found profitable to reverse the transplanting by using Northern seed South.

the safest position to withstand rains or frost, hence especially recommended in Northern latitudes.

In hauling, it is better to allow the seed tuft to remain attached until the cane has reached the works or some suitable place for preservation, and then cut, by the use of some heavy cleaver, in a rapid manner, not regarding a few inches of the spindling cane as lost if left with the tuft, as it is of more value for stock feed than for sugar.

It will be found more convenient to have cane bound in bundles until it reaches the mill, as in this condition there will be less waste or damage by breaking.

Care should be taken to avoid bruising it, as fermentation will soon follow, and the cane thus injured loses its freshness.

SEED TUFTS—THEIR VALUE, ETC.

IT is now admitted by all well-versed in the business, that the seed is of about the same value as corn of the same weight, and where fed in connection with the tuft end of the stalk and the skimmings of the works, it will fatten more stock than an acre of corn would from the same quality of soil, as usually fed. This suggests the importance of making provision for feeding at the start. It would not be difficult to so arrange mills that the seed on the tuft could be passed through between the rolls and crushed, thus materially improving the quality of the feed. This could be done at the close of the day and then thrown into the scum reservoir and well mingled with the hot scum and washings of the pans, tanks, etc., and form the required feed for the following day.

The reservoir should be sufficiently elevated to admit the fluid portion to be drawn off through troughs for hog feed, and the coarse fibrous portions thrown out for cattle. By these arrangements the entire offal and

trash found under foot and in sloughs about our country works can be turned into cash.

To effect this economic use of the offal, the larger class of works are more appropriate and profitable. This, however, is not the only benefit resulting from larger works. All the experiences of manufacturing operations prove that the larger the works the more profitable. The deficiency of skilled sugar boilers point to the central system as the source of relief, as it requires the same skill to effect good results on a small scale as on an enlarged one. When our efforts shall have demonstrated the paying results of this industry, we shall have connected with each central works an elaborate feeding establishment that can continue after the close of the sugar-boiling season, using some of the tanks for preparing food for stock, only requiring a mill for corn and other grain-grinding and a cutting box for chopping fodder, and thus utilize the works as a beef and pork factory during the Fall and Winter, converting the entire corn and fodder product of the neighborhood into cash at the maximum rate.

THE SYRUP AND SUGAR-BOILING OF 1879 AND 1880.

THERE has been less progress made than was expected by many, although fully up to my own expectation;—the great number of new beginners, with little or no previous experience, and many starting out with hopes inflated by assurances from distinguished sources that led them to adopt unreliable methods and processes that have been the cause of many failures. Some started out with a limited knowledge and expected to make a discovery that would make their fortune. But I have to record that the great source of failure has been in the inefficiency of the boiling trains, whether of steam or fire. It is a fatal error with most persons of inexpe-

rience to suppose that rapid boiling will burn the syrup, while exactly the reverse is the case. I have strenuously not only advocated rapid boiling, but the more rapid as the syrup approaches completion. This is in keeping with the methods in all the cane districts of the South, as well as the sugar refiners.

I am pleased to find one of the most successful small works of the past season is that of Clinton Bogarth, of ——— county, Iowa, who has made 17,000 gallons of a superior syrup, a large portion of which has granulated a light buff-colored sugar that polarized 89 when freshly taken. The barrel of Melado sent me, taken, as he says, from the top of his tank of several thousand gallons, which, of course, is hardly a fair sample, as the bottom will afford a better, this, however, swung out, in the presence of a committee from our Merchants' Exchange, the following result: Twenty pounds of Melado gave eight pounds of dry sugar that polarized 89 per cent., and the molasses from it polarized 49, showing a class of goods still superior to N. O., and susceptible, according to the statement given below, of producing four pounds more sugar per gallon if reboiled in vacuum.

Mr. Bogarth has conformed to the Southern method, by placing his heater next to his chimney, where he keeps a constant inflow of juice that he has previously treated with lime, but not to a full neutralization. In this heater he does no boiling, though a heavy scum is raised, which he only removes after some hours, when it becomes very heavy. I can readily understand the benefit of this scum blanket over this moderately heating juice, viz., it excludes the atmosphere, while the slow increase of the temperature greatly favors defecation.

In his process he dispenses with the settling tank, that has been considered beneficial. But we must be guided

by results. It is undoubtedly a loss to allow juice to rest expose to the atmosphere, not only in fuel, but in the tendency to fermentation. Therefore if such results can be had by a continuous ascending defecation and increasing heat, as has been done by Mr. Bogarth, then we must adopt it. It is well known that the continuous flow system has been quite successful, and now, by adding to it the equally well settled benefit of an increasing degree of heat as the syrup thickens, we shall be more certain of success.

The high grade of Mr. Bogarth's sugar and syrup, as given in the report of the well-known sugar refiner and expert, Mr. Charles Belcher, to the Merchants' Exchange, (given elsewhere), will be well calculated to sustain this method.

FUEL AND FURNACE ARRANGEMENTS.

INASMUCH as fuel constitutes a large item in the expense account of syrup and sugar-making, it is important to give close attention to this department. It was with this view, among others, that I was induced to make a lengthy tour the past Fall in the prairie districts of Kansas, and am pleased to know that the bagasse has proven to be the best fuel to be used for generating heat, either under the fire pans and evaporator, or under the steam boiler. The form of a furnace is quite simple and costs only a few dollars more than the ordinary. In fact, it can be attached to most furnaces now in use —the substitution of new grate bars and a fuel inlet that needs no door, as the bagasse, being fed in a constant jam, serves the purpose of a door. The space from grate to boiler must be greater than for a coal furnace, and the form of grate floor quite different. The arrangement of the flue back of the grate, as I found it in use by Mr. E. M. Rugg, of Marion county, performed

well, and was as follows: He raised a bridge wall in a few feet of the grates, within about seven inches of his boiler, and then drops down two feet or more, and then rises again at the back end of his pan to within five inches of it, but he has widened his flue a few inches. His chimney is twenty-five feet high and eighteen inches in diameter, which gives a strong draft. It is very easy in the construction of these bridge walls to finish with a course of brick, on which others can be added as the operations of the draft may call for. The pans in general use are light, and can be removed to allow such alterations to be made any morning while the furnace is cool.

I consider bagasse fuel preferable to wood or coal, from the fact that there can be kept up a more continuous flame, as the doors need not be opened to feed the furnace, and the further fact that the fire can be so soon withdrawn if occasion requires. This arrangement becomes more important when the method of boiling from the rear of the furnace to the front (as we must do if we are to make sugar from these canes), and the sooner we organize our works to this system, the sooner we shall realize our hopes. In the use of bagasse as fuel, unless the milling is very thorough and a furnace well adapted, it may become necessary to spread the bagasse a day to dry before burning. This firing will call for more close attention than coal or wood, but if results are satisfactory, then the point is gained. In small works a cheap hand can do the work, while larger ones will justify a full hand. For steam boiler furnaces it is quite as applicable, and the construction measuably the same. A flame can be projected nearly forty feet, giving off an intense heat, without the presence of that dense, sulphurous smoke so common to our inferior bituminous coal fires. Wood is so scarce in most of

our Western States that it is hardly necessary to make a comparison with it.

The use of the bagasse for fuel, as here indicated, I learned from Mr. Johnson, late from the Island of Dominica, where no other fuel is used, and this under the old-style round kettles of copper, placed four in a line, with heaters still back of these, from which the juice is drawn quite clear into the large kettle or grand. He says the scum rests quite a long time in this oblong heater, while the juice is running in and out constantly, the same as Mr. Bogarth is now doing with such success.

DEFECATORS AND EVAPORATORS.

In Mr. Bogarth's train he has dispensed with the settling process, limes his juice cold, runs it directly into what he calls a heater, though I should call it a defecator. This is placed on the back end of his furnace, next to his chimney, and elevated sufficiently to allow a flow through his next pan, that he calls a defecator. I would call it a clarifier, and this is above his evaporator and finishing pan. Now through this train from the mill he keeps a continuous flow, never allowing his heat to slacken a single degree, and all the time flowing his juice to a higher degree of heat as it thickens. This is in conformity to the methods of all the sugar-boiling of the Indies and the sugar districts of our own country. His success is the best evidence of the correctness of his method. I have repeatedly urged a change in this direction. I trust in the foregoing I have made the point sharp enough to arrest attention.

In reconstructing the boiling works now in use to embrace this feature as practiced by Mr. Bogarth, it will be necessary to lengthen the furnace flue and elevate it enough to draw from the bottom of the defecator into the back end of the evaporator, which should have a

slight incline to the front, where it may be drawn off as fast as it attains the desired degree.

There is a mistaken fear about scorching over a high heat. It must ever be remembered that no burning of good syrup takes place until reduced too thick for sugar. Therefore if the construction of the evaporator is such as to allow a free flow and rapid discharge when the thermometer or the practiced eye shall report it ready, then there is no danger of scorching. But if there has been a failure in the defecation and clarification, then the high heat of the syrup, say 228 deg. Fah., will not only scorch but burn black the foreign matter in the syrup, while the sugar itself is not scorched at all. If a baker were to put his bread, or a cook his loin of beef, in an oven where the thermometer shows 228 deg., each would be burned black in ten minutes. Even wrapping paper would be scorched when exposed to such heat. I make these illustrations to correct this erroneous idea, in order to get our operators out of this old rut of error.

SYRUP AND SUGAR-MAKING.

To make syrup is to make sugar; the only difference is in a few degrees on the thermometer. I receive many letters of inquiry from persons inexperienced in the whole business, as how to make sugar, not considering that syrup has first to be made before sugar. Then to make good syrup, is to do well the work referred to under the previous heading, and then reduce, by the most rapid evaporation possible, to the desired degree and then remove it from the fire or steam heat and cool it by some simple, certain method to about 150 deg. Fah., when it may be put into tanks or cisterns, where a temperature of about 90 to 110 deg. may be retained, and sugar will form of its own action, provided the

syrup possesses the quality to favor it. This quality can be tolerably well settled, by those of experience, by examining the cane and testing the juice with a saccharometer, especially the juices of the Orange and Amber canes, which have proven to be sugar-making canes. If the juice marks 10 deg. B. and over, the cane fresh and sound, there is no trouble in getting a fair return of sugar, varying in per cent, according to conditions. The juices of those canes marking less than 10 deg. B., will make sugar when finished in the vacuum pan, having been previously well handled and reduced to a semi-syrup of some 25 deg. B. This concentration need only be continued until the feculent matter is thoroughly removed. The lower the degree of heat that this can be effected, the more and better will be the quality of sugar and also the molasses that shall come from the centrifugal.

There has been so much confidence placed in some chemical compound by the use of which great results were to follow in sugar-making, that there has not been as much care taken to employ the well-known principles and methods, such as have been successful in sugar-making in all the sugar districts of the world. This, together with the erroneous method of boiling from the higher to the lower temperature of the train, has greatly retarded the progress of this industry. Now that the errors have been exposed by the many failures, and the success attending the compliance with the correct method has been shown, we may confidently look for a more rapid progress.

The degree to which syrup should be reduced for the best results in crystalization, will vary in different altitudes, as well as with the different varieties of the cane. Although the thermometer is the best general guide, nevertheless the finger or string test, when well under-

stood, will be more convenient and not subject to be effected by altitude. This test consists in catching a little syrup near at the close of the boiling upon the forefinger and touching it to the thumb and quickly drawing apart and noting the parting of the string. Should it break short and curl back instead of drawing out a fine thread without breaking, it is an evidence of sugar-making qualities and about ready to be removed from the fire.

There are apparently good reasons for not boiling these juices to as high a degree as is being done with the Southern cane juice: First, By the present methods there appears to be present in the Melado, when made too heavy, an adhesiveness that obstructs the purging even when well warmed and in a high speed of centrifugar; second, Coarser grain will form from a lower degree, and the purging therefore be more free; thirdly, The molasses from such low-boiled sugar will be more valuable, and the sugar of a higher grade. It is true more time will be required for granulation, and facilities for its accommodation arranged. This, however, can be provided for where thorough works are being erected. A building with high upper story for boiling, and a warm basement for granulating room, will effect the object. Should it become necessary to elevate the Melado, the expense will be trifling, having steam power to effect it. The use of sunken tanks, as indicated in the body of my book, have not yet been fairly tested. To make wooden tanks to hold this heavy syrup, requires the best seasoned plank and the most thorough workmanship.

An effort to lesson the cost, often not only increases it, but defeats the object entirely. Very many of our operators have in this way lost largely the past season by attempting to do their work with incomplete outfits.

It costs less to make syrup like Mr. Bogarth than it does the great mass of the dark, unsaleable article sent here for sale, the first selling readily at 40 cents and the latter dull at 25 cents—cooperage, freight, etc., just the same on each,—while the results financially are quite different.

It would be wise in those who first start up their works and produce a fair run, to send a sample to some person well versed in the quality of such goods and get an opinion, and if it is not of merchantable quality, set to work at once to correct it, instead of running on the whole season (as many have done) and lose largely thereby. We must admit our ignorance before we can gain knowledge. In most cases the lack of well-constructed evaporators and an effective heat, either steam or fire, has been the chief misfortune.

LETTER FROM MR. JOHN B. THOMS.

CHICAGO, ILL., March 22, 1881.

I. A. HEDGES, ESQ., *St. Louis.*

DEAR SIR: Your valued favor of the 20th at hand, and carefully perused. Tempering cold with lime, is the best method, as you can use more lime in that way, with less caromelization, to reduce to syrup. In other words, you cannot make a defecation without lime, or other alkalies, and in using it in the cold juice you can use more of it. A thorough defecation cannot be made with lime only, and reduced to syrup or sugar, without the aid of other agents, (at least that is my experience,) without producing a large percentage of caromel. I know of nothing better than your porous alum, as it is simple, effective and harmless, and I do not see how a man can well make good syrup without the use of it. I find the Sorgo juice very delicate, and requires treatment in accordance. Do I understand you that Mr. B. has separate defecators, holding a given number of gallons of cold juice, wherein he adds lime, or does he allow the lime water to flow with the juice in the defecator, where the scum is raised? If so, I should consider that a very poor way, as it would be difficult to equally distribute the lime juice. The former plan I consider by all means the best—having separate tanks or defecators, lime, then draw in clarifier or defecator to raise scum. There is one thing certain, some understand the soil necessary, and the method of cultivating the cane, better than others, it being so rich in sugar that you can hardly spoil it. From what I can learn, cane planted three and a-half feet apart each way, and on sandy soil, will make *sugar anyhow*. Boiling rapidly with hot fires, is absolutely necessary. Lowering the temperature while in process of boiling, by making green fires, in firing up heavily, always makes caromel. Now with your improvement of continually keeping the fires hot, thereby making a more uniform heat, you are bound to produce better results. The copper bottom you propose making for the pan, is *the thing* for various good reasons. Copper is a better conductor, easier kept

clean, etc., etc. The pocket you speak of for catching the scum, will be a great improvement. Mr. B.'s success is, no doubt, in his case, in using lime understandingly. From the fact that he used it in cold juice, speaks well for his good judgment. He, no doubt, had very good juice as well, which makes a vast difference, I can assure you. For example: at Crystal Lake, last year, where thirty or forty growers were hauling their cane, each load differing from the other, it was next to impossible to make a good defecation. We must be acquainted with the juice before we can treat it properly—like a doctor, *must* know the disease before we can prescribe a remedy. In Kansas, though the cane was impaired, I could make a perfect defecation, from the fact that the cane was all from one field, I could make the juice as clear as spring water—as you saw it. There is one thing certain, if the syrup-makers would use your porous alum, or some other agent, they would make better results; but they must try and use it intelligently, and I will here state, they cannot make as good syrup as those who do use it. The whole thing may be summed up as follows: with copper pans, strong, hot fire, care in defecating, satisfactory results *must* follow. Your ideas of what is needed for making syrup and sugar, are sufficient for me. There is only one objective point I see in the furnace arrangement, and that is, the difficulty in cleaning the fire, the grates being so low down. If you will permit me, I will suggest a plan for adjusting the baggasse box. It is as follows: I would have the fire-front made just like that of a steam boiler, with door hinges. You can remove the door, and, having eyes on the bagasse box, you can hook it on the hinges, and on the opposite side from the hinges, a catch. Now, should you wish to clean your fires, all you would have to do, would be to unhitch it, swing it back, just as you would the door when opening it.

Yours truly, JOHN B. THOMS.

REPLY TO MR. THOMS.

Mr. Bogarth limes cold in separate tanks, and then draws into his defecator. My feed inlets are hinged so as to be removed, and doors closed for using other fuel if desired.

The above valuabe letter came too late for inserting in its proper place and order. I. A. HEDGES.

CHAPTER XIV.

EXTRACT FROM MR. BELCHER'S REPORT TO THE ST. LOUIS MERCHANTS' EXCHANGE.

GEORGE H. MORGAN, ESQ., *Sec'y Merchants' Exchange:*

DEAR SIR: I received your note through Mr. I. A. Hedges, requesting me to go with him and examine samples of sorghum sugar and report thereon.

I found at Mr. Hedges' office one barrel of sorghum syrup and one of unpurged sorghum sugar. I have samples of each, which have been tested by the polariscope, and which I hand to you. The unpurged sugar —called "mush sugar" or "Melado"—is the cane juice boiled to a density at which the sugar in it crystalizes. Of this, twenty pounds, taken from the barrel in my presence, were put into Mr. Hedges' centrifugal, and the molasses swung out of it. The result was eight pounds of very dry sugar of good quality and twelve pounds of molasses, samples of which I also send you.

The tests by the polariscope were as follows:

A—Melado or unpurged sugar, 70 per cent.

B—Sugar from unpurged sugar, 89.5 per cent.

C—Molasses from unpurged sugar, 49 per cent.

D—Sorghum syrup, as received, 54.1 per cent.

The polarization of this sugar is equal to that of well-

drained Louisiana sugar or fair refining Cuba Muscovado sugar, and that of the molasses is a little less than the average of Louisiana and Cuba molasses. The sugar is of a quality that will sell readily for consumption at a good price, and the molasses from it is of very satisfactory quality and saleable. The sorghum syrup is of fine quality, light in color, sweet and of good flavor.

This syrup and unpurged sugar came from Mr. Clinton Bogarth, of Cedar Falls, Iowa, who writes to Mr. Hedges a description of his mill and apparatus and mode of manufacture.

His apparatus is very simple in its plan and arrangement, his cane being ground in common horse mills and the juice defecated and evaporated in flat metal pans over an open fire. The different pans are arranged and are set on the fire much like open kettles on a Louisiana sugar plantation, and his system of working is much the same. He speaks of twenty-one years' experience with sorghum, which seems to have brought him just where the Louisiana old-process planters stand. The bulk of his crop was sold in syrup, of which he made 17,000 gallons.

That sugar of good quality has been produced from sorghum in a number of places, admits of no question; and such sugar and syrup as this from Mr. Bogarth is of a quality that will readily command a good market. The quantity that can be produced, and the certainty of the crop, are yet unsolved problems. In Louisiana, the out-turn of sugar and molasses for market from the unpurged sugar, as boiled in open kettles, is 55 to 60 per cent. of sugar, and 40 to 45 per cent. of molasses. Where vaccum pans are used, the proportion of sugar is much greater. In this sugar from Mr. Bogarth the relative proportion is 40 per cent. of sugar, and 60 of

molasses. This is much less favorable than Louisiana sugar culture; yet, if a similar out-turn could be relied upon, the industry certainly would be worth the attention of farmers in this section of the country, and be worthy of the fostering care of the State government.

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CHARLES BELCHER.

ST. LOUIS, February 2, 1881.

MR. THOMS ON MR. BELCHER'S REPORT.

In reference to the 20 pounds of mush sugar or Melado, there was obtained from it 8 pounds of sugar and 12 pounds of molasses—polarizing 49 per cent. Molasses testing as high as that will yield 4 1-4 pounds of sugar to the gallon of molasses, weighing 11 1-2 pounds to the gallon, testing from 85 to 87, which sugar will be stronger in saccharine than any refined sugar you can buy. Now, let us reduce the 20 pounds of mush sugar to gallons of molasses, and see what undoubted yield of sugar can be obtained from the gallon of this same 20 pounds of sugar. There will be 2.07 gallons of molasses; there were 8 pounds of sugar taken from the 20, leaving 12 pounds of molasses, which syrup yielding 4 1-4 pounds of sugar per gallon, of 11 1-2 pounds to the gallon. Hence, 12 pounds yield 4.4 pounds of sugar and 6 24 pounds of syrup, or 54 per cent. of a gallon. Total product from the mush sugar or Melado, 8 pounds in first operation and 4.4 pounds in second operation, making 12.4 pounds; also, 6.24 pounds of syrup, or 54 per cent. of a gallon; or, yield of sugar per gallon of said mush sugar reduced to syrup, weighing 11 1-2 pounds to the gallon, would be 6 1-2 pounds of good family sugar.

There is no surmising these results, for they are our working figures in the East. We very rarely receive

molasses from Cuba testing 51 polarization—we get more below 50 than over. Having had the experience of working from 10,000 to 20,000 hogshead per annum for the last twelve years, I should here state that the above results can only be obtained by boiling the syrup in a vacuum pan. The result of boiling molasses testing 49 or under in an open pan, would prove unprofitable. The yield of 8 pounds from the 20 Mr. Belcher writes of, is about all the sugar that could be obtained by the open-pan method. Had the juice been handled by a skillful operator, the yield of sugar would have been larger; so you can readily perceive the difference in favor of the vacuum pan and having an experienced operator.

The quality of sugar would be far superior if boiled in vacuo, both in point of grain and color; the syrup would be also a great deal lighter in color. Be it understood that every pound of foreign substance left in the juice or syrup, prevents its weight in crystalization. It takes many years to make one proficient in the art of defecating the juice and boiling the sugar, especially the former.

Yours, etc.,

JOHN B. THOMS.

CHICAGO, ILLINOIS.

CHAPTER XV.

SUGAR REFINING.

BY GEO. C. W. BELCHER.

ALTHOUGH the refining of sugar is properly a business quite distinct and different from its production, and although they will probably always remain separate, yet as the same principles and theories underlie both, it is not out of place to refer here at some length to sugar refining as now successfully practiced.

The processes which most effectually and economically refine sugar, and at the same time preserve it, as far as possible, from inversion and waste, are the processes which should be imitated, as far as practicable, by the producer of the crude article. In his system of working, he will be guided by his means, the size of his crop, and the capacity of the market which he can supply, and by incidental emergencies, of which he is the best judge. Holding up to him an ideal which is unattainable, except in the largest manufacturing centers, is not to be considered as discouraging him, but rather as giving him a good working model, which he will necessarily fall somewhat short of, but will strive to imitate, as far as may lie within his power.

It is impracticable to refine sugar, except in solution. In this state, heat is the constant cause of inversion. The effect of heat is to be measured not merely by the quantity at any one instant, but by the length of time during which the sugar is exposed to its action. Evidently, then, both reduction of the temperature and shortening of the time required in working, are desirable. *This idea is the foundation* of the surest and most lasting progress lately made in sugar-refining.

The dissolving or "melting" of the raw sugar, is done by stirring it in water, usually warm. The shape of the vessel is generally cylindrical, and the shaft or stirrer is vertical, with lateral arms. More commonly the "sweet-waters" or thin washings from the boneblack filters, are used here to save the cost of evaporation.

There is a radical difference of theory in this process between the English and American refiners, the Americans melting their sugars on the ground floor, or in their raw-sugar warehouses, with as little labor and handling as possible, and then pumping the solution or "liquor" to the top of the house. The English, on the contrary, prefer to hoist the raw sugar in bulk and melt on the top floor, claiming to prevent a deterioration caused by pumping. This system is undoubtedly more clumsy and expensive. No satisfactory figures to prove its benefits, are available to the writer, and in default of sufficient testimony to the contrary, the American practice which now obtains, must be esteemed preferable.

In former times much stress was laid upon the operation of "clearing," or "blowing-up," as it was termed. This feature in the process of sugar-refining has dwindled away to comparative insignificance. A slight heating (say, to 180 deg. Fah.) is sufficient to prepare the liquor for bag-filtration, and to get it through the

bags without delay, and as heavy as practicable, is all that the modern working demands. The use of clarifying agents which formerly obtained in this department, has been done away with, although for boiling "hard" sugars, some refiners still prefer liquor that has been cleared with blood.

The absolute necessity for a defecation of some kind as the cheapest method of purifying cane juice, is, of course, not obviated by the more homœopathic treatment now in favor with refiners. There is an entire dissimilarity in the situation and circumstances. What may be the better method theoretically, and also practically in a refinery, may, on the contrary, prove expensive and inefficient in plantation work. It is, in any event, evident that sugar-refining experience in this department has little advice to offer to the producer or manufacturer of raw-sugars.

The next stage in the refinery work is a filtration of sugar-liquor through cloth. It is almost universal in houses working raw sugars made from the cane, to use bags. These bags vary in dimensions, according to the particular fancy of the refiner, but are generally about six feet long, and sixteen to thirty-two inches wide. They are, of course, open at one end only, and are suspended, mouth upwards, (often to the number of several hundred) in a case called a "filter." To prevent the bursting liable to happen by the distention of the bag, each bag is sheathed by a coarse-textured sleeve about seven inches in diameter, open at both ends, and a little longer than the bag. The bag and sheath are tied to a brass casting which screws on to a nipple fitted in the top plate of the "filter-case."

The method of working is simply running the liquor upon the top plate of the "filter," whence it discharges into the bag and filters through. The first liquor

through a bag is always a little murky, but it soon becomes transparent or "bright," owing to the lining of the bag with gummy matter. After a longer or shorter period, the filtration gradually stops, and the bags must be removed from the cases and cleaned by washing.

The present system of bag-filtration is very cumbrous and imperfect. About two or three hundred pounds of raw sugar is all that can be filtered through a bag and sheath, which necessitates an immense amount of labor in handling and washing, besides much wastage in sweet-water, etc. A small percentage of sweets is invariably lost in the bags, and when the number used daily runs up among the thousands, the figure is considerable. In addition, the probability of bursting, and the evils resulting from dumping a bag full of scum and dirt into the clear-filtered liquor, are apparent. The most careful watching will not prevent this recurring a number of times during the day. The refiner has then the option of allowing the foul liquor to run directly upon the boneblack at the expense of its decolorizing and purifying power, or of refiltering the whole of the contaminated portion of the liquor. If bag-filtration could be made always sure and perfect, the improvement in the decolorizing action of the boneblack, and the reduction of the quantity used, would be marked.

In this connection it is important to call attention to a recent invention* which has met and overcome the obstacles that have hitherto prevented a perfect bag-filtration. It consists in abolishing altogether the external sheath, and suspending within the bag a small perforated re-inforcing tube. The direction of filtra-

* This invention is the property of the patentee, Mr. Belcher, and certainly deserves all the commendation which he has given it. Its workings, so far, are better than his expectations. I. A. H.

tion is changed, being from the outside to the inside of the bag. The casing in which the bags are hung is strengthened, being generally cylindrical and of wrought iron, and the bags can be thus subjected to a large amount of pressure without any possibility of bursting. By these changes the amount of cloth used in filtering is reduced fully seventy-five per cent.; there is *no possibility* of bursting any bags, the necessity of constant care and watching is obviated, and the scum and dirt, being on the *outside* of the bags, is removed with little washing. It is not necessary to take out the bags after every filtration, as they can be cleaned while hanging in the case, by water and steam.

This method of bag-filtration is the only one that can be used with profit by the producer of raw sugar, as the amount of cloth needed is by it brought within his means. As regards the necessity of removing all mechanical impurities (i. e. those held in suspension), it is unnecessary to speak; and the inadequacy of the "settling" system has long been felt.

After bag-filtration comes *the feature* of sugar-refining, viz., boneblack filtration. A large portion of the seeming advantages possessed by one refinery over another, lies in the proper working of the boneblack. But to describe the criterions of good boneblack, and the details of its handling, is beyond the limits of this article. The subject is also properly an outlying region which the producer of raw sugar does not need to touch. As far as the writer is aware, the use of boneblack is being gradually abandoned on plantations. Indeed, it is now handled and reburned by refiners in enormous quantities daily at such a small cost as to make any successful competition by parties with limited means and inadequate machinery out of the question.

Undoubtedly some sort of effective filtration is the

feature which the production of raw sugar from the cane particularly lacks, but the method of accomplishing this desirable end must be simpler and cheaper than the boneblack method. The growing tendency to substitute in sugar-refining mechanical for chemical means, would indicate that a purely mechanical filtration—say, through gravel or cloth—will ultimately answer the requirements of the raw-sugar producer.

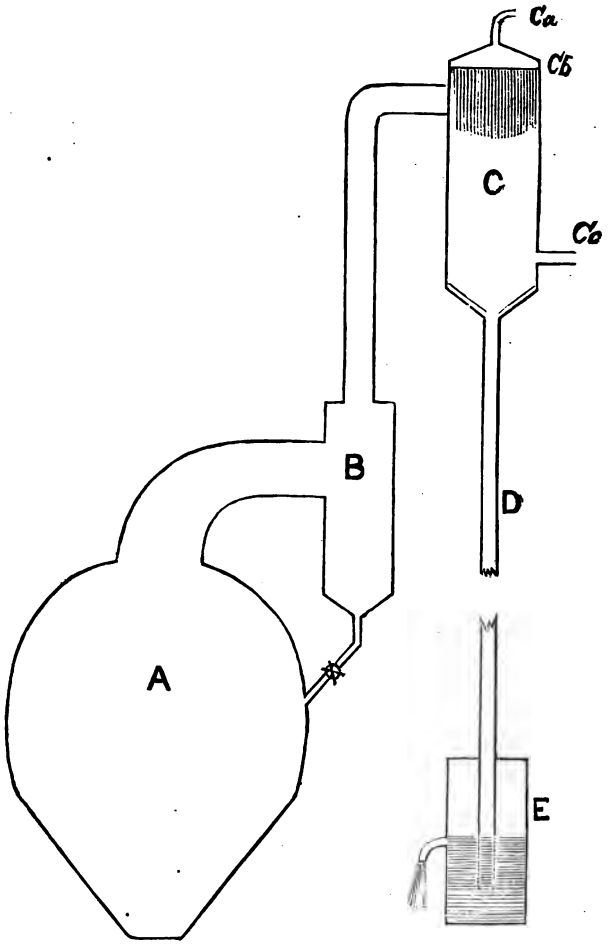
The vacuum-pan in a refinery corresponds to the finishing-pan in a factory, and the different stages of the two processes can be compared, both forward and backward, from this point. Boneblack-filtered liquor is, of course, much purer and better prepared for the crystallization of sugar than the raw cane-juice at the same stage of its treatment, for the action of the boneblack, besides removing coloring matters, has also absorbed gums, salts, iron oxide, etc., in a greater or less degree. It is usually about the density of evaporated cane-juice, say 25 to 28 deg. Beaume.

Boiling *in vacuo* is a feature in sugar-refining of the utmost importance and one which belongs equally to the manufacture of the crude article. For this reason we give it especial prominence. It is, defining it with reference to its purpose, the evaporation of water and the consequent separation of sugar (we are speaking of a solution of sugar) in crystals, under such abnormal conditions of temperature as reduce the destruction of cane-sugar to a minimum. What this minimum may possibly be cannot be at present determined. Sugar can be crystallized at a temperature of 100 deg. Fah., and less, but how much less? The obtaining of these extreme results is not, however, necessary for good vacuum boiling. A temperature of 130 to 150 deg. Fah. is to be had without any extraordinary precautions, and

will produce effects surprising to persons accustomed only to boiling in open pans. The principle of boiling *in vacuo* is simple, and needs little or no explanation for any one who has seen a well-constructed apparatus.

In the outline sketch on the following page, *A* represents a vacuum-pan. *B* is an "over-run," a vessel to catch and retain any particles of sugar that may be thrown out of the vacuum-pan by the violence of the ebullition. *C* is a "condenser," a vessel in which the vapors from the boiling charge are condensed, usually by the injection of cold water. *C a* is a pipe for injecting water for this purpose, *C b* is a perforated plate for breaking up the injection-water into spray, and *C c* is a pipe connecting with an air-pump. *D* is a pipe to outlet the enormous amount of water received in the the condenser. This pipe descends into a cistern *E*, which overflows at a point higher than the mouth of the pipe. This pipe (called the "tail-pipe") should be for a "dry vacuum" not less than thirty-four feet in length from the bottom of the condenser to the surface of the water in the cistern *E*; for the pressure of the atmosphere will support a column of water nearly that height in a perfect vacuum.

The arrangement of the steam-pipes ("coils" or "worms," as they are called,) in the vacuum-pan, is not shown in the sketch. These points, and many others, will naturally suggest themselves to the reader. Vacuum-pans are made in various shapes. The writer has seen some that resembled a mushroom top, others a horizontal cylinder; the egg-shape (point downwards) has been most in favor. In size they vary from toys three feet in diameter to monsters sixteen feet in diameter and capable of boiling a strike of more than 150,000 pounds. Every steam coil (there may be one or a doz-


Ca
Cb
C
Cc
B
D
A
E

en) in a vacuum-pan should have a separate inlet and outlet with valves; the condensed steam-water from the worms is an item which very soon attracts the attention of the novice. One thermometer, at least, is necessary to determine the temperature of the boiling charge. A vacuum-gauge is needed. Eye-glasses in the pan are used for viewing the operation, and a brass rod (called a "proof-stick"), adapted to take samples of the "strike," is absolutely necessary. A large copper pipe is used for charging with liquor. Many other devices are also needed, mention of which we will omit here.

The operation of boiling consumes at least from one to two hours, and may last much longer. The character and condition of the apparatus, the quality of the material operated upon, and the ability and faithfulness of the person in charge; all affect the result, and all must be taken into consideration. It is a process which cannot be satisfactorily described in a few lines, and we therefore omit all description. It requires care and study, and whatever features may, in practice, at first seem to contradict any preconceived notions and hypotheses, will be found really to rest upon the profoundest scientific theories.

It should be remarked in passing that the quantity of water used for condensing the vapors from a vacuum-pan is surprisingly large. Large refineries consume millions of gallons daily. No vaccum-pan can be worked without an abundant supply, and this fact should be taken into account before locating an expensive and complicated plant of machinery.

We will suppose the boiling of a strike of sugar to be just completed; the steam has been turned off, the air-pump and water-pump have been stopped, and the air admitted to the pan by opening cocks and valves provided for that purpose. A valve at the bottom of the

pan is now opened, and the strike runs slowly out and through a gutter into a receiving-vessel (called a "mixer"), which delivers it as desired to the centrifugal machines. This mixer contains a horizontal shaft, with arms, which slowly revolves and keeps the commingled mass of sugar-crystals and syrup from settling into a solid cake, as it would do if it were allowed to remain quiet. The mixer should be large enough to hold the contents of the pan, and the strike should be dried in centrifugals without delay.

Since up to this time, as far as the writer is aware, no strike of sugar, boiled from sorghum cane-juice, has been "swung direct from the pan," it is proper that some attention be called to boiling "blank," i. e., without graining in the pan. This consists in evaporating the charge to a certain point (differing with the quality of the "liquor") at which the sugar crystals begin to form and from which they will grow without further evaporation. Of course, under the same circumstances the amount of crystallized sugar obtained by this method is *never* as large as by crystallization in the vacuum pan.

As to the boiling, the density and temperature of the goods at the moment when the strike is finished, will depend entirely upon the polarization and other characteristics of the charge, besides various circumstances. The sugar-boiler must "feel his way" very carefully until he is satisfied with the "proof." Then, from this point, he will vary his boiling according to the test, quite intelligently and with a large degree of certainty.

Beside the boiling, there are two points to be especially watched. Firstly, the strike must be kept perfectly quiet after the wagons or tanks are filled. Any movement whatever of the mass disturbs the regular formation and growth of the crystals, and may prevent

subsequent "drying" in the centrifugal. (There is, however, an exception to this rule. When a strike of sugar, either through too hot boiling or any other cause, "heats up," it is necessary to stir it, in order to let the heat escape. Such a strike is always more or less damaged. The appearance of foaming and frothing, and the elevation of temperature in the "heating" portions, cannot be mistaken.) Secondly, the strike must be kept warm. A temperature of about 100 deg. Fah. is best. Between 90 and 110 deg. Fah. it may vary without material loss, but the strike must never be suddenly chilled. Upon this point depends almost everything. The manufacturer of sorghum sugar will find any extra expense involved in the construction of a "hot room," by double partitions, exhaust steam pipes, etc., amply repaid by the increased yield of sugar and the saving of labor in "swinging," etc. A single strike spoiled through chilling, will prove very expensive, as it probably cannot be re-crystallized in an open pan. Hence the risk of incurring loss, is far greater when the manufacturer has not the facilities of vacuum boiling.

A well-boiled strike of sugar, after standing in wagons long enough to complete the crystallization, and ready for "drying" in the centrifugal, resembles a mass of concrete, or, to an unaccustomed eye, a big cake of maple sugar. It is soft enough to be spaded out of the wagons, but must be stirred to a uniform consistency before charging the centrifugal machines. The mixer that receives the strikes (whose crystallization is completed in the vacuum pan) is not strong enough for this purpose. A smaller mixer is used, having instead of wooden arms, knife-shaped iron arms, arranged usually in a spiral around the shaft, and cutting between other "knives" fastenened to the sides of the mixer. If the strike, after crystallization is complete, should be cooled

by removing the wagons or a change in temperature of the room, it should again be warmed by standing in a "hot-room," in order to expedite the "mixing," and assist the "drying" in the machines. Any addition of water, hot or cold, to the mass, will certainly, whatever good it may accomplish by improving the color or aiding the syrup to purge, decrease the yield in sugar.

The refining and recrystallizing of the sugar having been completed, there remains the separation of the sugar-crystals from the syrup with which they are commingled. In former times this was universally accomplished by simple gravitation, the syrup being allowed to drain from the sugar in small conical moulds, the whole mass being kept warm. A similar process now is the purging of Muscovado sugars on plantations in barrels and hogsheads. At the present time it is general in refineries to expedite the "drying" of the sugar by centrifugal force. A centrifugal machine is shaped like a band-box, uncovered, but with a sort of rim. The side or "ring" is made very strong, usually of steel, and perforated with many small holes. It is lined with brass wire-cloth, and is revolved very rapidly upon a central shaft. The mingled mass of sugar and syrup is thrown up against the inside of the ring by the centrifugal force, and the syrup is driven through the holes, while the sugar crystals are retained in the basket.

Some kinds of centrifugals rest upon bed-plates and are driven from below; others are suspended and driven from above. Power is commonly applied by belting. The machine proper, or "basket," is surrounded by a strong iron "tub," which is large enough to allow some oscillation or play of the basket. It serves to catch the syrup that is driven the perforations in the basket. This syrup is carried off by a little gutter at the bottom of the tub, and either reboiled for sugar, or if that is

impracticable, worked into molasses. The drying of the sugar takes a longer or shorter time, according to the quality of the "goods," and the efficiency and speed of the machine. Hard-grained sugars are usually "washed" with a little pure water while the machine is running, in order to improve the color.

Preference can hardly be given to either "under-" or "over-driven" machines. The latter generally save labor, if the building has sufficient height; still some "underdriven" machines discharge the sugar at the bottom as handily as any "hanging" machine. In all cases when the machines are not carefully examined at frequent and regular intervals, it is better to have the tubs made strong enough to hold the basket in case of an explosion. In fact it is always safer, as a flaw in the ring may remain undiscovered and the machine tear apart while "swinging" some tough, gummy "strike" of sugar.

This chapter is already too long to allow any space to be given to the subject of shovelling, mixing, packing and storing refined sugars. Customs and views vary considerably on these points, and the whole subject is not so mysterious but that good common sense well-applied will keep an interested party safe from going far astray.

A few lines must be added in explanation of the terms "polariscope," "polarization of sugar," etc. The "polarization" of sugar is the effect, as compared with pure cane sugar, which the sample produces upon polarized light. A solution of sugar does not polarize an ordinary ray of light; but upon light which has been polarized by quartz or some similarly acting substance it has a very marked action, which is considered, theoretically, to be a rotation of the plane of polarization. By means of this action or rotation, one sample of sugar can be compared with another, because the impuri-

ties present in raw sugar, such as sand, gum, water, etc., are considered as having little or no effect upon polarized light. In point of fact, the majority of impurities in raw sugars do affect the rays of polarized light, and some in a marked manner. But notwithstanding this, "polarization" is the most efficient and reliable test for the commercial valuation of raw sugars and for guiding the working of a refinery.

The polariscope is the instrument used for "polarizing" sugar. It looks like a small telescope mounted and pivoted upon a central stand. The style of polariscope in ordinary use in this country (the Ventzke-Soleil) receives the rays of light from the flame of a coal-oil lamp or gas-burner, and after allowing it to become polarized by passing through a Nicol's prism, transmits it through a certain length of a solution of sugar, and then through quartz crystals, by increasing or decreasing the thickness of which, the effect of the sugar solution can be neutralized. This amount is measured by a small scale with vernier attached, and the effect is compared with that of cane sugars. The weight of sugar dissolved, the volume to which the solution is extended, and the length of the solution (filled in a tube), all remaining constant, one sample of sugar can be compared with another by observing the different thicknesses of quartz required to neutralize the effect. The scale is graduated so that can sugar reads 100: this is not 100 degrees, but 100 per cent. cane-sugar. In other words, the scale is simply one of relation.

It can be readily inferred that the polarization of sugar is subject to many inaccuracies, some inherent in slight, but unavoidable, variations of volume, temperature, etc.; others depend upon the ability and care of the operator. Such as it is however, this test stands pre-eminent above all others as a quick, handy and approximatively correct estimation of cane-sugar.

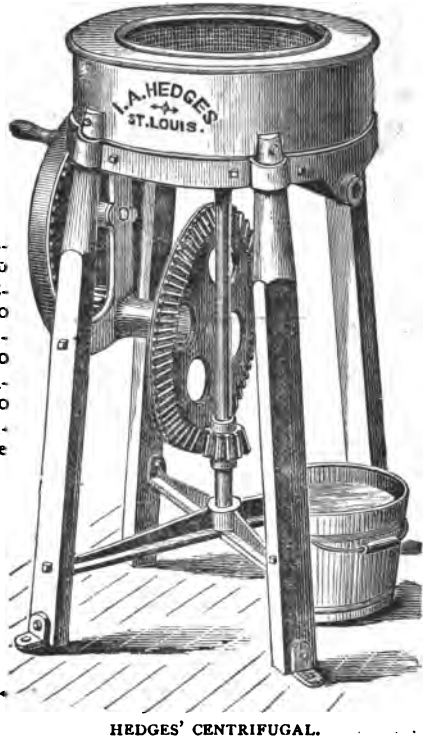
No. 1, Hand geared, 18-inch disc, - - - $45.00

No. 1, same for belt, 18-inch disc, - - - $50.00

No. 1, combined, for alternate use, - - $55.00

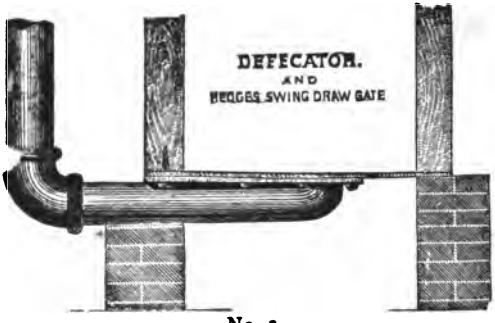
No. 2, Power mach., 24-inch disc, - - - $85.00

Larger machines by special orders, prices will be given.



HEDGES' CENTRIFUGAL.

This machine has met the needs for small operators, and, being simple and durable, will last to pave the way for large establishments where those costing several hundred dollars will take their place. No. 1 will swing two gallons Melado at one charge and in about ten minutes. No. 2, four gallons in same time. Melado should be about blood-warm, and made limpid by mixing. Special directions will accomqany each machine sold. The process, however, is quite simple.



No. 1.

No. 2.

No. 3.

No. 1. Sectional view of defecator, with swing draw-gate, well proven for drawing from the bottom of all pans or defecators, 2-inch - - - $5.00

do, 3-inch, - - $7.00

No. 2. Tin test-cup for using Saccharometer in, - - 50 cts.

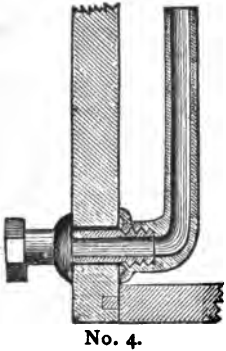
No. 3 Sugar Thermometer, Fah. scale, to be used in hot syrup, - - - - $2.00

No. 4. Swing-pipe for drawing tempered or defecated juice from the top by swinging down the inner end, 1 1-4 inch, - $1.50

do, 2-inch, - - $2.50

No. 5. Beaume Saccharometer, used in cold juice or hot syrup, to test its weight, water being 0 heavy, syrup 36° hot, - $1.25

No. 6. Proof-glass for inspecting defecated juice or semi-syrup. In order to make comparisons, each operator should have two or more, - - - - 50 cts.



No. 4.

No. 5.

No. 6.